Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Use of Portions of Returned 2 GHz	)	IB Docket No. 05-221
Mobile Satellite Service Frequencies	)	

COMMENTS OF
TMI COMMUNICATIONS AND COMPANY LIMITED PARTNERSHIP
AND TERRESTAR NETWORKS INC.

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SUMMARY

TMI/TerreStar are constructing a robust and innovative hybrid satellite/terrestrial system that will provide, for the first time, wireless mobile voice and broadband services to small, lightweight and inexpensive consumer handsets literally everywhere in the United States from the moment commercial service is launched – even in the most remote and rural locations. This system will provide public safety and homeland security with a uniquely valuable communications asset; it will provide reliable broadband services to rural America; it will provide a competitive spur to incumbent wireless service providers; and it will expand spectrum reuse, innovation and efficiency to an unprecedented level. But it cannot accomplish these goals without sufficient spectrum.

To make this system possible, TMI/TerreStar urge the Commission to promptly distribute the remaining 2 GHz MSS spectrum on a *pro rata* basis to existing MSS licensees. Providing each MSS licensee with 2 x 10 MHz of spectrum will advance four of the Commission's most important strategic objectives:

- ***Public Safety and Homeland Security.*** TMI/TerreStar's hybrid satellite/terrestrial network will enable emergency responders and homeland security end users to have seamless communications using the same low-cost, broadband-capable device in any emergency anywhere in the country. Today's national security concerns dictate that sufficient spectrum must be available to provide emergency responders and homeland security end users with the certainty that, when the need arises, a full-featured and reliable MSS system with adequate spectrum will be available. By providing TMI/TerreStar with access to 2 x 10 MHz of spectrum, the Commission will provide TMI/TerreStar with the necessary capacity to continue its efforts to develop a platform for important emergency response and homeland security wireless applications.
- ***Spectrum.*** Access to adequate amounts of spectrum will enable TMI/TerreStar to provide innovative use of spectrum, including deployment of state-of-the-art 3G and 4G wireless technologies, 2 Mbps — and potentially greater — wireless packet data rates, and the engineering of a transparent system that offers a user experience that is similar in features, size and cost to today's cellular/PCS services.
- ***Broadband.*** If TMI/TerreStar has access to adequate amounts of spectrum, it can use its hybrid satellite/terrestrial network to further the Commission's objective that all Americans have affordable access to robust and reliable broadband products and services. By operating the

largest and most sophisticated commercial mobile satellite ever, TMI/TerreStar will enable people to have access to high-speed mobile data applications on consumer electronic equipment in all areas of the country, no matter how remote.

- ***Competition.*** If not spectrum constrained, TMI/TerreStar can compete vigorously with numerous existing mobile services, including at least three other national satellite service providers, the Broadband Radio Service, Wi-Fi service providers, and four or five nationwide cellular/SMR/PCS providers.

This amount of spectrum is essential to permit TMI/TerreStar to (1) achieve the economies of scale needed to produce inexpensive and innovative user equipment; (2) produce sufficient revenue to justify the expensive and high-risk undertaking associated with building its system; (3) engineer its system in a way that provides extraordinary spectrum efficiency; and (4) incorporate the latest air interface protocols to provide maximum throughput to local areas in the event of an emergency. The decisions that the Commission makes today will be relevant not only in the near term, but for the fifteen-year plus life of the satellite, and a mistake made today could prevent the TMI/TerreStar satellite from being a viable competitor in the mobile communications marketplace and fulfilling its promise to advance public safety and homeland security.

Other potential uses of the available MSS spectrum would provide fewer, if any, public interest benefits. The initiation of a processing round to assign the available spectrum to a new entrant (or entrants) would leave all 2 GHz MSS providers with access to insufficient spectrum and would significantly delay service to the public. Reallocation of the spectrum to add it to the massive amount of spectrum already available (and soon to be available) to terrestrial mobile uses would provide no appreciable public interest benefits. Neither of these options would provide the American public with the unique benefits that will be offered by TMI/TerreStar's system.

The Commission has ample legal authority to redistribute the recaptured spectrum to the existing licensees in the 2 GHz MSS service in this proceeding. TMI/TerreStar urge that the Commission take this step as quickly as possible.

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The Commission has the opportunity in this proceeding to create the conditions for deployment of a Mobile Satellite Service ("MSS"), with Ancillary Terrestrial Component ("ATC"), that will be used to provide a full complement of services to benefit all Americans and enhance public safety and homeland security. TMI Communications and Company Limited Partnership and its affiliate, TerreStar Networks Inc. (collectively, "TMI/TerreStar")[1] urge the Commission to move quickly to redistribute the remaining 2 GHz MSS spectrum on a *pro rata* basis to each of the existing licensees in the 2 GHz MSS band, TMI/TerreStar and ICO Satellite Services ("ICO").[2]

[1] TerreStar is the prospective assignee of TMI's 2 GHz MSS authorization and, pursuant to an agreement with TMI, has contracted with Space Systems/Loral Inc. for a satellite that will operate in this band.

[2] *See Commission Invites Comments Concerning Use of Portions of Returned 2 GHz Mobile Satellite Service Frequencies*, Public Notice, FCC 05-134, IB Docket No. 05-221 (rel. June 29, 2005) ("Second Redistribution Notice").

The Commission already has stated its intention to redistribute 2 x 2.67 MHz of spectrum to the existing licensees.[3] With the additional distribution considered in this proceeding, each of the 2 GHz MSS licensees will have access to the 2 x 10 MHz of spectrum that is essential to create a ubiquitous, redundant, interoperable wireless voice and broadband data service.

INTRODUCTION

In the Second Redistribution Notice, the Commission proposed three alternatives for redistributing or reallocating the one-third of the 2 GHz MSS spectrum: (1) dividing the spectrum equally between TMI/TerreStar and ICO; (2) initiating a processing round to select a new MSS licensee or licensees; and (3) reallocating the spectrum to another service.

TMI/TerreStar demonstrates in these comments that the first option — redistributing the spectrum to the remaining 2 GHz MSS licensees — will best serve the public interest. Redistributing the spectrum to the remaining licensees will expedite service to the public by placing the spectrum in the hands of parties who are in a position to make use of it in the near term. Such a redistribution also will advance the Commission's strategic plan objectives, and will enable TMI/TerreStar and ICO to: (i) serve almost 50 percent more members of the public than with only 2 x 6.67 MHz; (ii) achieve the economies of scale needed to produce handsets that are comparable in size, weight, function, and cost to those that consumers expect to use with terrestrial-only

3 *See Commission Invites Comments Concerning Use of Portions of Returned 2 GHz Mobile Satellite Service Frequencies*, Public Notice, FCC 05-133, IB Docket No. 05-220 (rel. June 29, 2005) ("First Redistribution Notice"). These comments assume that the existing 2 GHz MSS licensees have each been assigned one-third, or 2 x 6.67 MHz, of the 2 x 20 MHz of spectrum allocated to the 2 GHz mobile satellite service pursuant to the FCC's announcement in IB Docket No. 05-220.

mobile networks; (iii) optimize the system for public safety, homeland security and national defense; and (iv) avoid technical obsolescence of a satellite that must last for what will be many generations of new, high-capacity air interfaces. As demonstrated in these comments, a full 2 x 10 MHz of 2 GHz MSS spectrum is necessary to ensure that the 2 GHz MSS systems are successful and are able to provide full-featured and ubiquitous service to rural and other underserved users, the homeland security and public safety communities, and to the American public.

The reassignment of this spectrum is also essential because the TMI/TerreStar and ICO satellites will have a useful life of at least 15 years from launch (*i.e.,* until 2022) and hence the FCC must ensure that the spectrum available to these satellites is sufficient for them to meet their public service obligations, including homeland security, in 2010, 2015, 2020, and beyond. The holder of a license must build its system to accommodate technological innovations and adaptations. Thus, the 15-year satellite lifecycles and critical public safety mission of the licensees strongly suggest the wisdom of assigning the small, incremental amount of spectrum requested here to TMI/TerreStar and ICO.

The other potential options for the available MSS spectrum, on the other hand, would yield few, if any, public interest benefits. The initiation of a processing round to assign the available MSS spectrum to an additional 2 GHz MSS operator would impose significant delay, leave all 2 GHz MSS providers with access to insufficient spectrum, and consign the three operators to compete for limited MSS niche services, which could well be a prescription for failure.

Reallocation of the available spectrum to terrestrial wireless services would provide little public benefit, either absolutely or relative to the benefits that would be provided by assignment of 2 x 10 MHz to the existing licensees. In its comments on the First Redistribution Notice, TMI/TerreStar demonstrated that it is essential that the 2 x 20 MHz allocation to MSS be maintained and that the frequencies surrendered by Iridium and Boeing be divided between TMI/TerreStar and ICO.[4] Assuming that the FCC does so, the terrestrial reallocation option set out in the Second Redistribution Notice would yield only an additional 2 x 6.67 MHz to terrestrial wireless, which would be a wasteful addition to the some 175 MHz of spectrum already allocated, but unassigned, to terrestrial carriers.

In contrast, distributing that same amount of spectrum to each of the existing 2 GHz licensees would give each a full, useable complement of 2 x 10 MHz of spectrum, which is essential to create a unique, ubiquitous, interoperable satellite/terrestrial network offering voice and broadband data services that will benefit emergency responders and homeland security and national defense agencies, as well as all Americans, wherever they live. Maintaining this spectrum for MSS also will have the benefit of preserving a scarce international spectrum allocation for an international, and potentially global, service. If this spectrum is instead simply added to the substantial amount of spectrum allocated for domestic terrestrial services, the potential for using these frequencies for innovative international satellite services will be lost.

Moreover, any alternative other than distribution of the remaining MSS spectrum to the existing licensees would cause the available spectrum to lie fallow for

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4 These comments, and TMI/TerreStar's April 19, 2005 letter to Donald Abelson, Chief, International Bureau, are incorporated by reference.

years beyond 2008, when TMI/TerreStar will initiate commercial service. TMI/TerreStar is moving forward rapidly to construct and operate its new system Through the efforts of TerreStar's principal owner, Motient, more than $200 million of equity investment has been raised for a hybrid satellite/terrestrial network, which is the first step in the full financing of what will be an expensive and high-risk undertaking. With this financial commitment, on April 11, 2005, TMI submitted a certification to the Commission stating that, as of March 31, 2005, it had timely met the "begin physical construction" milestone for its GSO satellite. That satellite, TerreStar-1, will be the world's largest and most powerful commercial mobile satellite, capable of generating hundreds of spot beams to provide coverage throughout the United States (including Alaska and Hawaii), Puerto Rico, the U.S. Virgin Islands and much of Canada.[5] TerreStar-1 and its terrestrial component will communicate directly with consumer handsets that will be comparable in size, cost and features to those available on terrestrial-only networks.[6] TMI/TerreStar has raised significant funds, met construction milestones, designed a unique technically sophisticated, high-capacity mobile telecommunications network, and optimized it for service for the public benefit. What is missing is the certainty of adequate spectrum resources that will make the promise of this network a reality. The Commission should move quickly to add that missing element by providing the existing 2 GHz MSS licensees with spectrum resources of 2 x 10 MHz.

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5 *TerreStar to Construct the World's First Satellite that Can Communicate With a Cell Phone*, TerreStar Networks, News Release (rel. April 11, 2005).

6 TMI/TerreStar plan to file an application with the Commission seeking authority to provide an ancillary terrestrial component immediately upon meeting the Commission's gating criteria. *See Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Bands*, Memorandum Opinion and Order, IB Docket No. 01-185, FCC 05-30, at ¶ 89 (rel. Feb. 25, 2005) ("*ATC Reconsideration Order*").

I. REDISTRIBUTING 2 GHz MSS SPECTRUM TO THE REMAINING 2 GHz MSS LICENSEES WILL SERVE THE PUBLIC INTEREST.

Four of the five goals identified in the Commission's draft Strategic Plan as high priority objectives of communications policy are essential to this proceeding: improving the communications capability of public safety/homeland security, improving spectrum efficiency and innovation, improving broadband availability, and enhancing competition.[7] Providing the remaining 2 GHz MSS licensees access to adequate spectrum will advance all four goals. In brief:

- ***Public Safety and Homeland Security.*** TMI/TerreStar's hybrid satellite/terrestrial network will enable emergency responders and homeland security end users to have seamless communications using the same low-cost, broadband-capable device in any emergency anywhere in the country. Today's national security concerns dictate that sufficient spectrum must be available to provide emergency responders and homeland security end users with the certainty that, when the need arises, a full-featured and reliable MSS system with adequate spectrum will be available. By providing TMI/TerreStar with access to 2 x 10 MHz of spectrum, the Commission will provide TMI/TerreStar with the necessary capacity to continue their efforts to develop a platform for important emergency response and homeland security wireless applications.
- ***Spectrum.*** Access to adequate amounts of spectrum will enable TMI/TerreStar to provide innovative use of spectrum, including deployment of state-of-the-art 3G and 4G wireless technologies, 2 Mbps — and potentially greater — wireless packet data rates, and the engineering of a transparent system that offers a user experience that is similar in features, size and cost to today's cellular/PCS services.
- ***Broadband.*** If TMI/TerreStar has access to adequate amounts of spectrum, they can use their hybrid satellite/terrestrial network to further the Commission's objective that all Americans have affordable access to robust and reliable broadband products and services. By operating the largest and most sophisticated

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[7] Public Notice, *Public Invited to Review Drat Strategic Plan* (rel. July 5, 2005) ("Strategic Plan"); *see also Reply Comments of TMI and TerreStar*, IB Docket No. 05-220 (July 25, 2005).

commercial mobile satellite ever, TMI/TerreStar will enable people to have access to high-speed mobile data applications on consumer electronic equipment in all areas of the country, no matter how remote.

- ***Competition.*** If not spectrum constrained, TMI/TerreStar can compete vigorously with numerous existing mobile services, including at least three other national satellite service providers, the Broadband Radio Service, Wi-Fi service providers, and four or five nationwide cellular/SMR/PCS providers.

A. The TMI/TerreStar Network Will Become a Unique and Essential Tool for Homeland Security.

One of the most important of the Commission's goals is to enable the development of communications systems that are ubiquitous across the nation, fully redundant and reliable, interoperable and have sufficient capacity to carry critical communications services for public safety, homeland security and national defense. In this regard, Commission here has an opportunity to facilitate the first of the United States Government's defense network policy goals, which is to:

- Achieve a ubiquitous, secure and robust network
- Eliminate bandwidth, frequency and computing capability limitations
- Deploy collaborative capabilities and other performance support tools
- Secure and assure the network and the information.[8]

It is difficult, if not impossible, to achieve these goals using existing wireless communications networks. Advanced security applications cannot continue to be dependent on networks with a variety of protocols, varied bandwidth, and competing

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8 United States Dep't of Defense, *ASD(NII)/DoD CIO Goals*, *available at* http://www.defenselink.mil/nii/homepage.html (last visited July 29, 2005).

commercial priorities and products. The Commission has an opportunity in this proceeding to avoid these deficiencies by creating the regulatory conditions that will foster a next-generation, ubiquitous, interoperable nationwide wireless system. Such a system will permit the public safety and security entities at the federal, state and local levels to plan, design and deploy critical advanced security applications without undue delay, complication or excessive cost.

The most important regulatory condition is for the Commission to provide each of the presently licensed 2 GHz MSS systems access to the full 2 x 10 MHz of spectrum that is available. If these systems are confined to less than 2 x 10 MHz, they will not have sufficient capacity to deploy on an economically and technically sound basis the types of advanced security applications that are being developed. Interconnection via existing communications systems, particularly fiber networks, is not feasible because many important sites are outside the metropolitan areas where dense networks are located. A hybrid satellite/terrestrial system with sufficient bandwidth could fill this requirement.

In 2004, the National Security Telecommunications Advisory Committee ("NSTAC"), in its Satellite Task Force Report to the President, found that the commercial satellite industry is critical to national, economic, and homeland security.[9] The innovative mobile satellite systems with terrestrial components that are being developed in the 2 GHz band can advance this vision, provided that they have access to 2 x 10 MHz of spectrum. Additionally, such a commitment of spectrum to such systems

[9] National Security Telecommunications Advisory Committee, *Satellite Task Force Report: Fact Sheet* (Feb. 2004), http://www.ncs.gov/nstac/reports/2004/Satellite%20Task%20Force%20Fact%20Sheet%20(March%202004).pdf.

will give those charged with providing homeland security and national defense the certain availability of a commercial network that is optimized for their needs and with sufficient capacity to accommodate critical communications solutions as they develop. Only TMI/TerreStar and ICO are in the position – in the near term – to achieve that goal.

By proving TMI/TerreStar with access to 2 x 10 MHz of spectrum, the Commission will provide TMI/TerreStar with the necessary capacity to continue its efforts to develop a platform for important emergency response and homeland security wireless applications. The needs of public safety and the homeland security community and the applications they demand are unlikely to be met with limited amounts of spectrum which do not allow public safety and homeland security planners access to the latest technologies. As discussed in the remainder of Section I, today's technology and the technology of the future requires increasingly broad amounts of spectrum. If granted access to 2 x 10 MHz of spectrum, TMI/Terrestar is committed to continue to work actively with emergency responders, homeland security entities and private companies to explore fully the advanced national security, homeland defense and public safety applications that can only reasonably be done through a robust, next generation hybrid satellite/terrestrial network. If the defense/homeland security community is relegated to MSS systems with too little spectrum to utilize the latest technologies, then the defense/homeland security is relegated to relying on yesterday's technology. 2 x 10 MHz of spectrum, together with TMI/Terrestar's advanced hybrid satellite/terrestrial network and intellectual property, and our commitment to work aggressively with this essential community of agencies and private sector companies, maximizes the likelihood of innovative new security applications that combine the benefits of terrestrial and satellite networks. This should facilitate a more secure United States for all Americans.

B. A 2 x 10 MHz Spectrum Assignment Is Required For TMI/TerreStar to Produce Mobile Telecommunications Service That Meets the Commission's Spectrum Efficiency Goals.

In designing its next-generation MSS/ATC system, TMI/TerreStar was guided by the competitive necessity to give consumers ubiquitous access to mobile communications services using affordable but small and multifunctional mass-produced consumer electronic handsets. These handsets will be very similar in size and features to the handsets that consumers use today for access to terrestrial-only wireless networks. The benefits of the TMI/TerreStar network, which are today not available from any mobile communications service provider, will dramatically increase the quality and value of mobile services available to American consumers.

1. Consumer Benefits of TMI/TerreStar's Uniquely Powerful Satellite

As noted, TMI/TerreStar is designing and building a satellite system that will be capable of providing a range of voice and high bit-rate data services to hand-held receivers that will be essentially indistinguishable from those available from terrestrial-only carriers, which is the *sine qua non* of offering a competitive mobile telecommunications service rather than the expensive niche service that prior MSS services became.[10] To accomplish this essential goal, the TMI/TerreStar satellite will use the largest reflector ever flown on a commercial satellite (over 18 meters in diameter) to provide high gain spot beams of approximately 0.25 degrees in diameter. Bolstered by

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[10] Through discussions with equipment vendors, TMI/TerreStar has determined that this "transparency" principle, whereby the MSS handset is essentially indistinguishable in form, price and function from a terrestrial mobile handset, is crucial to the competitive viability of an MSS/ATC service.

higher-power amplifiers, the antenna can deliver an Aggregate Equivalent Isotropic Radiated Power ("AEIRP") of 80 dBW, which is substantially more than any commercial MSS satellite launched to date.[11]

This powerful satellite will enable TMI/TerreStar to provide broadband satellite service to consumer-friendly handsets that have RF characteristics, in terms of their output power and receiver sensibility, similar to ordinary cellular/PCS handsets. Specifically, the significant AEIRP and receive sensitivity of the satellite eliminates the need for a special satellite-optimized air interface. Instead, mobile handsets can use minor modifications of existing air interfaces and an inexpensive RF chain to provide the service. As described in the attached technical statement, 2 x 10 MHz is necessary to ensure that all AEIRP is utilized.[12]

Also, because of this significant AEIRP, the 50 percent increase of spectrum will actually *double* the number of users served by the satellite.[13] Moreover, all of the spectrum used by the satellite for the delivery of service will be efficiently reused by the ancillary terrestrial component. This spectrum reuse will permit consumers to realize the benefits of a nationwide ubiquitous, mobile satellite service with access at every point in the nation regardless of topology while ensuring the efficient use of the spectrum resource.[14]

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11 Having committed to using an 18 meter reflector to provide service to small, lightweight handsets, the additional cost of higher-power amplifiers was nominal, or less than one percent of the cost of the satellite.

12 *See* Technical Appendix.

13 *Id.*

14 The Commission recently has reiterated that ATC would "advance the Commission's goal of ensuring efficient and intensive use of the spectrum." *See ATC Reconsideration Order* at ¶¶ 9 and 95.

2. State-of-the-Art Air Interfaces

TMI/TerreStar is designing its MSS/ATC system to provide a full complement of communications services, including circuit-switched voice, Push-to-Talk, Short Message Service, and on-demand broadband multimedia content. To deliver these benefits, the TMI/TerreStar network must accommodate the same set of broadband air interface protocols, that are essential to the provision of high-speed packet-switched communications by any mobile network.[15] This requires access to 2 x 10 MHz of spectrum.

As explained in the attached Supplementary Declaration of Peter Cowhey, Dean of the Graduate School of International Relations and Pacific Studies at the University of California, San Diego, "[t]he rate of innovation in wireless technology in extremely high."[16] Current channelization for CDMA voice and data transmission requires 1.25 MHz-wide channels. Newer technologies, upon which next-generation wireless handsets will be built, use even wider bandwidths.

Third-generation broadband air interface standards that require carrier bandwidths of 5 MHz already have been deployed in Europe and Japan; one example of such a standard is W-CDMA. The trend is toward the deployment of even wider band carriers to overcome multipath and increase throughput. As discussed in the Technical

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15 As described below, a competitive system requires that the end user device be hand-held and functionally interchangeable with a traditional terrestrial wireless handset. Because accommodating different protocols for the satellite and ATC components of the system would necessitate a dramatic increase in size of the end user device, TMI/TerreStar intends to implement the same set of protocols throughout its hybrid system. Moreover, TMI/TerreStar cannot use antiquated protocols, or develop their own proprietary protocols, because this would preclude them from implementing in their system new and innovative communications technologies as they become available.

16 *See* Supplemental Declaration of Peter Cowhey at 3.

Appendix and of particular utility to public safety and homeland security, TMI/TerreStar may deploy a 10 MHz wide fourth-generation air interface that will greatly increase its ability to provide maximum capacity to a single local area in the event of an emergency. In order to procure and distribute next-generation handsets and other end-user devices, and to continue to keep pace with ever-increasing technological innovation and the adoption of new industry standards to reflect such innovation, TMI/TerreStar must design its system to able to accommodate use these new industry-standard wireless protocols without which it would simply not be feasible for manufacturers to engage in consumer-scale production of handsets.[17]

As Cingular recently stated in the AWS service rules proceeding, "[T]he current direction of technology development to support higher bandwidth applications and advanced technologies requires wider channel bandwidths, not . . . narrow [2 x 5 MHz] bandwidths…."[18] These technological changes are not surprising; wide channel bandwidths offer many advantages, including greater multipath resistance and higher burst throughputs for data services. A small amount of additional spectrum will thus allow the TMI/TerreStar to offer higher average speeds for data and accommodate evolving complementary terrestrial technologies in a flexible manner.[19]

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17 TMI/TerreStar's market research indicates that including satellite technology in today's consumer wireless handsets would raise the price of each handset no more than approximately $5 per unit. *See* Letter from Nils Rydbeck, Rydbeck Consulting to TerreStar (dated July 28, 2005) (Attachment 2 to Technical Appendix) ("Rydbeck Letter").

18 Letter from David Wye, Executive Director, Federal Regulatory Affairs, Cingular Wireless, to Marlene H. Dortch, Secretary, FCC, WT Docket No. 02-353 (filed May 11, 2005).

19 *See* Supplementary Affidavit of Peter Cowhey at 3.

Moreover, as noted, the life expectancy of its satellite is 15 years or longer from launch, which means that TMI/TerreStar will need to have the spectrum necessary for its services and handsets to remain competitive with the terrestrial wireless industry for the entire life of the satellite — *i.e.,* beyond the year 2020.

C. The Requested Spectrum Redistribution Will Allow Residents of Rural Areas to Experience Broadband and Digital Voice Services Similar to Those Available in Urban Areas.

TMI/TerreStar's system will be capable of significantly improving the speed and sophistication of communications services in rural and other underserved areas. Because the powerful satellite signal will allow handset manufacturers to produce low cost devices, consumers in underserved areas will gain access to high-quality telecommunications services at reasonable cost. For many Americans in rural and remote areas, this will be the first time that they have access to reliable mobile voice and advanced mobile data technology at affordable prices.[20] As explained in the attached Declaration of Peter Cowhey, "[F]or residential and SME customers who are purely in the rural market there are, in many cases, no alternatives for this kind of integrated voice and data service."[21]

Of particular importance, in keeping with President Bush's call for broadband access "in every corner of America"[22] by 2007, TMI/TerreStar's system will provide advanced mobile data services to the entire continental United States, Alaska and

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20 Rural consumers using a booster antenna attached to their PC may be able to achieve speeds as high as 2 Mbps.

21 Declaration of Peter Cowhey at 2.

22 President George W. Bush, Remarks at the U.S. Dep't of Commerce (June 24, 2004) ("Sometimes the problem we face here in America is that technology is available in maybe just the big cities… What we're interested in is to make sure broadband technology is available in every corner of America by the year 2007.").

Hawaii, Puerto Rico, the Virgin Islands, and significant portions of Canada, from the start of its operations. Access to this technology is particularly vital to residents of areas corresponding to the five percent of United States zip codes with *no* access to advanced data services.[23] There are few, if any, other technologies and services available that directly respond to the President's call for broadband service to all Americans with the same comprehensive coverage and cost-effectiveness as a hybrid satellite/terrestrial system.

By ensuring that the mobile data and voice services offered by TMI/TerreStar's MSS network reach rural America, the requested spectrum distribution will also advance the Commission's statutory responsibility to "encourage the deployment on a reasonable and timely basis of advanced telecommunications capability to all Americans."[24] As then-Commissioner Martin explained in the Commission's Fourth Report to Congress concerning the availability of advanced telecommunications capability in the United States, "[a]ccess to broadband services is especially important to rural America, providing business, educational and healthcare opportunities to remote parts of the country."[25]

As noted above, the Commission's draft strategic plan for 2006-2011 similarly emphasizes that the Commission "shall continue to encourage and promote broadband development, deployment, and availability, particularly to those in rural, low-

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[23] *See High Speed Services for Internet Access: Status as of December 31, 2004*, Industry Analysis and Technology Division, Wireline Competition Bureau, FCC, at 4 (rel. July 7, 2005).

[24] Telecommunications Act of 1996 § 706, 47 U.S.C. § 157.

[25] *Availability of Advanced Telecommunications Capability in the United States, Fourth Report to Congress*, 19 FCC Rcd. 20540, Statement of Commissioner Kevin J. Martin (2004).

income, or underserved areas."[26] Like the Commission's other recent efforts at facilitating the deployment of broadband to rural and remote parts of the country – such as the adoption of streamlined licensing mechanisms in certain spectrum bands[27] and an Order to "promote access to spectrum and facilitate capital formation for entities seeking to serve rural areas or improve service in rural areas"[28] – distribution of the remaining 2 GHz MSS spectrum to TMI/TerreStar and ICO is consistent with the Commission's responsibility to facilitate the availability of advanced telecommunications capability to *all* Americans.[29]

D. With Access to Sufficient Spectrum, the 2 GHz Mobile Satellite Service Will Serve as an Important Source of Competition.

1. Competition In The Market For Mobile Telecommunications

Analysis of the effects of the number of competitors in a market requires appropriate definition of the "market." In general, neither frequency bands nor other regulatory categories are markets. The Commission should not rely on a rule of thumb or presumption calling for a minimum number of licensees in a given band, because, in general, such a presumption is likely to be unrelated to consumer welfare.

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26 Strategic Plan at 6.

27 *Wireless Operations in the 3650-3700 MHz Band*, Report and Order and Memorandum Opinion and Order, ET Docket No. 04-151, FCC 05-56, at ¶ 1 (rel. March 16, 2005) (adopting policies to "stimulate the rapid expansion of wireless broadband services — especially in rural areas.").

28 *Facilitating the Provision of Spectrum-Based Services to Rural Areas and Promoting Opportunities for Rural Telephone Companies To Provide Spectrum-Based Services*, 19 FCC Rcd. 19078, 19080 (2004).

29 Numerous other legislative measures proposed to enhance rural consumers' access to data technology underscore the importance of serving rural areas. *See, e.g.*, Broadband Rural Revitalization Act of 2005, S. 497, 109th Cong. (2005); Rural America Digital Accessibility Act, H.R. 144, 109th Cong. (2005). Congress has also established a Rural Broadband Access Loan and Loan Guarantee Program, which in fiscal year 2004 made over $2 billion available for constructing broadband service to qualified rural communities. *See* 19 FCC Rcd. at 19102.

By providing the two licensees in the 2 GHz MSS band with sufficient spectrum to deploy a robust MSS/ATC service, the Commission will promote competition in the the market for mobile communications. TMI/TerreStar's hybrid terrestrial/satellite system will compete vigorously with numerous existing mobile services, including at least three other national satellite service providers, the Broadband Radio Service, Wi-Fi providers, and cellular/SMR/PCS providers. Consumers deserve the full benefit of that competition, which will only occur if 2 GHz MSS providers have sufficient spectrum to bring successful next-generation offerings to market.

Specifically, if provided enough spectrum, TMI/TerreStar will be a potential voice and high-speed data communications option for consumers in *every* market in the United States. This competitive alternative could alleviate the concerns raised by the recent wave of consolidation in the terrestrial wireless industry, which may soon be dominated by just four national carriers, assuming that the merger of Sprint and Nextel is approved.[30] As noted below, that industry controls more than 200 MHz of spectrum, and as the Commission has recognized, access to spectrum is important to a provider's ability to compete.[31] The assignment of the full 2 x 10 MHz of spectrum will allow a spectrum-efficient competitor into the market, resulting in consumer choice for advanced services in all markets in the United States.

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30 *See, e.g.*, Comments of the National Rural Telecommunications Cooperative, WT Docket No. 05-63, at 1 (March 30, 2005) (expressing concern that merger of Sprint and Nextel, and particularly consolidation of these entities' 2.5 GHz holdings, "may block competitors from obtaining access to licensed broadband spectrum, stifle competition and limit choices for wireless broadband services — especially in rural America, where fewer broadband choices are available.").

31 *See, e.g.*, *Applications of Western Wireless Corp. and ALLTEL Corp.*, Memorandum Opinion and Order, FCC 05-138, WT Docket No. 05-50, at ¶ 111 (rel. July 19, 2005).

The competitive thrust of the 2 GHz MSS providers could be particularly important in rural areas, where consumers have access to far less mobile (or fixed) communications providers than do their counterparts in more densely populated areas.[32] At a time when terrestrial wireless carriers are fighting for regular subsidies from the overburdened Universal Service Fund to provide competition to such areas, TMI/TerreStar is prepared to provide truly ubiquitous high-speed data and voice coverage from the moment its system begins commercial service without the addition of subsidies.[33]

In addition to creating a competitive and affordable alternative for consumers of terrestrial wireless services, TMI/TerreStar will use the additional spectrum to provide intraservice competition to other MSS providers in the L-band, 1.6/2.4 GHz ("Big LEO"), and Little LEO bands, such as Inmarsat, Globalstar, MSV, and ORBCOMM. Of course, TMI/TerreStar also will compete with ICO.

2. Enabling Use Of Consumer-Priced Handsets

As we have stated, having inexpensive consumer-market handsets is the *sine qua non* to offering a competitive mobile service and having sufficient bandwidth is the prerequisite to being able to have manufactured sufficient handsets to capture economies of scale. Assuming that the TMI/TerreStar system uses one set of standard protocols for both satellite and ATC communications, adding satellite capability to existing consumer handsets would add no more than $5 to the manufacturing cost of each

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32 *See, e.g.*, *Annual Report and Analysis of Competitive Market Conditions With Respect to Commercial Mobile Services*, 19 FCC Rcd. 20597, 20643 ¶ 109 (2004).

33 *See Federal-State Joint Board on Universal Service*, 20 FCC Rcd. 6371, 6388 ¶ 37 (2005) (describing terrestrial wireless carriers as "the largest group of competitive [eligible telecommunications carriers] that the Commission designates.").

unit.[34] Without these scale economies provided by mass production, the costs of production will be prohibitive and the MSS industry cannot hope to meet the well-recognized consumer expectations of full-featured, powerful and small digital handsets.

Specifically, and as explained in the Declaration of Peter Cowhey, a competitive handset/terminal "means that TMI/TerreStar has to achieve the economies of the mass consumer electronic industry."[35] To make that effort worthwhile, any manufacturer will expect a minimum production run of substantially over one million units per year. Even that quantity, however, will be too small to keep costs at a level competitive with handsets for large terrestrial systems. Therefore, TMI/TerreStar believes that a single vendor will require a potential market of approximately 1.5 to two million units per year in order to supply new equipment. Moreover, to maintain a competitive supply of handsets, TMI/TerreStar must have access to at least three vendors, or about 4.5 to six million handsets.

Of course, no vendor, and much less three, will manufacture that many handsets unless TMI/TerreStar has sufficient network capacity to handle customer demand. Factoring in customer churn (*i.e.*, the percentage of customers leaving TMI/TerreStar in a year), rates at which handsets are replaced by new models, and the degree to which competitors for integrated satellite/terrestrial systems may have similar equipment orders, TerreStar has concluded that maintaining a sales volume for three vendors at the minimum scale over a multi-year period necessitates a system capable of supporting between fifteen to twenty-five million customers. It is estimated that at least 2 x 10 MHz is required to serve such a significant volume of MSS/ATC consumers.

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34 *See* Rydbeck Letter, Attachment 2 to Technical Appendix.

35 Declaration of Peter Cowhey at 4.

II. THE OTHER OPTIONS UNDER CONSIDERATION FOR USE OF THE AVAILABLE MSS SPECTRUM WOULD NOT SERVE THE PUBLIC INTEREST.

As noted above, TMI/TerreStar is roughly two years from launch and three years from delivering its unique mobile telecommunications services. Accordingly, redistributing a *pro rata* share of the spectrum to the remaining 2 GHz MSS licensees is the only way of ensuring that the spectrum will be used to provide service to the public in the foreseeable future. Any proposal for reallocation or redistribution of the 2 GHz MSS spectrum would be ill advised and contrary to the public interest.

Conducting a processing round for new MSS entrants also would detract from the Commission's objective of expediting service to the public. Before 2 GHz MSS spectrum could be used in this scenario, new applications would have to be solicited; the qualifications of new applicants would have to be evaluated; spectrum would have to be assigned to the applicants determined to be qualified; milestones would have to be imposed; and satellites would have to be contracted for, constructed, launched, and placed into operation. This procedure would delay the use of the surrendered spectrum for five to seven years.

Similarly, allocating 2 GHz MSS spectrum to terrestrial wireless services would have a decidedly anticompetitive and counterproductive effect. Before 2 GHz MSS spectrum could be used for terrestrial purposes, the Commission would need to conduct a reallocation rulemaking; the spectrum would need to be added to the large amounts of unused, unassigned spectrum that is already available to terrestrial wireless carriers; the spectrum would have to be auctioned; the qualifications of the auction winners would have to be examined; and systems would have to be constructed.

The need to take these steps would delay the initiation of service for many years. It would also jeopardize the provision of high-speed data and other advanced services in remote and rural areas, because those are the areas for which it is less economic for terrestrial systems to provide ubiquitous coverage. Because of the ubiquitous nature of the TMI/TerreStar hybrid satellite/terrestrial system, in contrast, service will be provided to the entirety of the rural geography of the United States.

A. A New Processing Round Would Be Counterproductive, Delay Consumer Access to the Spectrum, and Impair the Long Term Viability of the 2 GHz MSS.

If the Commission were to open a new processing round to assign the remaining 2 x 6.67 MHz of available MSS spectrum to a new entrant, or multiple entrants, to the 2 GHz mobile satellite service, it will deprive *all* licensees in the 2 GHz MSS band – TMI/TerreStar, ICO and the new entrants – of access to sufficient spectrum. Such action would jeopardize the viability of next-generation MSS and would be to the detriment of the public interest.

The Commission should not rely on *a priori* judgments that the market will support a third or more 2 GHz MSS competitor or that each licensee can make due with access to just 2 x 6.67 MHz of spectrum. After a period of some competitive uncertainty for the 2 GHz mobile satellite service, the remaining licensees are well on their way to launching a robust mobile voice and data service to the public under a timely milestone schedule.[36] The financial market's willingness to support these ventures,

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[36] In addition to the above-described accomplishments in TMI/TerreStar's satellite design plans, the Commission's decision to grant ICO's request to operate a geostationary-satellite-orbit ("GSO") system instead of a nongeostationary-satellite-orbit ("NGSO") system provided further stability to the 2 GHz MSS industry. As the Commission noted in that decision, "This action will enable ICO to proceed with

however, could be severely tested if the FCC unreasonably caps the spectrum available to the licensees and artificially seeks to restructure the market by opening a new processing round.[37]

Contrary to claims made by Inmarsat in a separate proceeding, there is no credible evidence that it or any other satellite company can construct and finance a third 2 GHz MSS system on the small amount of spectrum that would, without the spectrum requested in this docket, be available. Inmarsat has told the FCC that "it stands ready to use the 2 GHz band to deploy an expansion MSS system … by the end of the decade…."[38] However, Inmarsat's asserted need for any 2 GHz MSS spectrum before 2010 is highly suspect because this assertion is flatly inconsistent with recent public statements made to its investors in securities filings in the United Kingdom that it intends *not* to invest in any new satellites.

Last month, in connection with Inmarsat's historic initial share listing as a private company on the London Stock Exchange, the company issued a 279-page prospectus, later updated to June 17 by a 16-page supplement.[39] At no point in this lengthy disclosure document – which was issued well after Boeing, Iridium and Celsat had surrendered their licenses and two months after TMI/TerreStar had requested the

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implementation of a 2 GHz MSS system on a schedule that will result in timely institution of new service." *ICO Satellite Services G.P./Application for Modification of 2 GHz LOI Authorization/Petition for Declaratory Ruling or Waiver*, 20 FCC Rcd. 9797 ¶ 1 (2005).

[37] *See* Section I(D)(2), *supra.*

[38] Reply Comments of Inmarsat Ventures Ltd., IB Docket No. 05-220, at 3 (July 25, 2005); *see also* Comments of Inmarsat Ventures Ltd., IB Docket No. 05-220, at 7 (July 13, 2005).

[39] *Id.*

reassignment of the forfeited spectrum – does Inmarsat specifically mention any plans to construct and launch a follow-on 2 GHz MSS system in the United States. Moreover, a review of the prospectus shows that the company will be fairly heavily indebted after the $1.5 billion deployment of its new fleet of three Inmarsat-4 satellites which have a 15-year life and will not be fully operational until 2007, at earliest. Specifically, Inmarsat stated in its securities filings in June 2005 that "once we deploy our Inmarsat-4 satellite fleet, we do not anticipate the need for material capital expenditure for a new generation of satellites until 2014 at earliest."[40] Accordingly, Inmarsat is not committed to exploiting the 2 GHz band, but, at best, is simply acting the spoiler to hinder new competitive entry.

Inmarsat also has told prospective investors that it already has more than twice the amount of MSS spectrum now assigned to TMI/TerreStar and ICO, and that it does not require additional bandwidth to meet its next-generation service needs.[41] In particular, Inmarsat's prospectus discloses that it has "an aggregate allocation of 14 x 2 MHz in the North American region based on usage" with 20 x 2 MHz in other regions, which Inmarsat states "provide sufficient spectrum to support our next generation service...."[42]

Finally, Inmarsat had once before professed an interest in the 2 GHz MSS spectrum but, as the Commission is well aware, once a firm commitment to this band drew near, Inmarsat said it had changed its mind in favor of constructing a new L-band

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40 *See Inmarsat plc Prospectus, available at* http://about.inmarsat.com/investor_relations/default.aspx, at 69, 79 (June 1, 2005).

41 *Inmarsat plc Prospectus, supra*, at 45.

42 *Id.*

satellite system.[43] As noted above, Inmarsat's prospectus confirms that that is still the case today, and will continue to be so through at least 2014.

In sum, Inmarsat has had a fair opportunity to obtain 2 GHz spectrum and, since 2000, as its prospectus reaffirms, the company has chosen a different band for its satellite services. Faced with a clear conflict between the statements Inmarsat recently has made to the Commission and those that it made to its investors and to securities regulators in the United Kingdom, in which it was required by law to be both truthful and complete,[44] it is clear that Inmarsat's official statements must take precedence; its belated claim that it would now participate in the 2 GHz MSS band is simply not credible. Inmarsat should not now be allowed to short-circuit the FCC's appropriate management of the 2 GHz MSS band, or the *Satellite Licensing Reform Order*, and disrupt the development of a robust, consumer-based 2 GHz MSS/ATC service.

B. There is No Justification for Reallocating MSS Spectrum for Terrestrial Use.

Just two years ago, the Commission reallocated nearly *half* of the 2 GHz MSS spectrum, or 30 MHz, for future use by the terrestrial wireless industry.[45] The

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[43] In 2000, after filing a Letter of Intent ("LOI") application in the first 2 GHz MSS processing round, Inmarsat withdrew its LOI, explaining that "[d]ue to the planned launch of the Inmarsat 4 system, Inmarsat no longer believes that it will be in a position to launch and operate a mobile satellite system in the 2 GHz band." Letter from Kelly Cameron, Powell, Goldstein, Frazer & Murphy LLP, counsel to Inmarsat, to Magalie Roman Salas, Secretary, FCC (Nov. 21, 2000) (attached at Exhibit D).

[44] United Kingdom securities laws, like those in the United States, penalize any false or misleading statements or omissions in an offering prospectus and the creation of any false or misleading impressions made in connection with proposed investments. *See* Financial Services and Markets Act 2000, Sections 118, 123, 392(2).

[45] *Amendment of Part 2 of the Commission's Rules to Allocate Spectrum Below 3 GHz for Mobile and Fixed Services*, 18 FCC Rcd 2223, ¶ 32 (2003). CTIA - The Wireless Association ("CTIA") sought reconsideration of this decision on grounds that the Commission had not re-allocated *enough* spectrum away from MSS. *See* Petition for Reconsideration of CTIA, ET Docket No. 00-258, IB Docket No. 99-81 (filed April 14,

spectrum reallocated for terrestrial use, in addition to another 150 MHz of spectrum reallocated from other services, will be made available to terrestrial wireless providers starting next year.[46] This flood of spectrum will nearly double the already considerable spectrum holdings of that industry, which is collectively assigned at least 200 MHz of spectrum nationwide. In contrast, the entire 2 GHz mobile satellite service consists of only 40 MHz of spectrum.

Reallocating the small amount of spectrum at issue here would provide few benefits to the terrestrial industry that it will not already realize with the significant amount of spectrum that recently has been made available to it. As discussed above, however, this spectrum is essential to the ability of MSS licensees to provide full-featured service to the public. Distributing that same amount of spectrum to each of the existing 2 GHz licensees will give each a useable complement of 2 x 10 MHz of spectrum; this will permit TMI/TerreStar to provide a unique, ubiquitous, interoperable satellite/terrestrial network offering voice and broadband data services that will benefit emergency responders and homeland security as well as all Americans, wherever they live. Maintaining this spectrum for MSS also will have the benefit of preserving a scarce international spectrum allocation for an international, and potentially global, service. If this spectrum is instead simply added to the large amount of spectrum already allocated

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2003). Reaffirming that "MSS use of this spectrum would serve the public interest," the Commission dismissed CTIA's petition in Sept. 2004. *Amendment of Part 2 of the Commission's Rules to Allocate Spectrum Below 3 GHz for Mobile and Fixed Services to Support the Introduction of New Advanced Wireless Services, Including Third Generation Wireless Systems*, 19 FCC Rcd. 20720, 20761 ¶ 96 (2003).

[46] Specifically, the FCC has indicated its intent to auction 110 MHz for advanced wireless services in the 1.7-2.1 GHz spectrum and 60 MHz of spectrum to be vacated by television broadcast licensees at the conclusion of the transition to digital television. The Commission already has awarded 5 MHz of the MSS spectrum to Nextel.

for domestic terrestrial services, the potential for using these frequencies for innovative international satellite services will be lost. The public interest will be served by maintaining this spectrum for MSS.

III. THE COMMISSION HAS AMPLE LEGAL AUTHORITY TO REASSIGN RECAPTURED 2 GHz MSS SPECTRUM OUTSIDE OF A NOTICE-AND-COMMENT RULEMAKING AND TO RESOLVE THE SPECTRUM REASSIGNMENT IN THIS DOCKET SEPARATELY FROM THE SPECTRUM REASSIGNMENT PROPOSED IN IB DOCKET NO. 05-220.

As the Public Notice in this proceeding explains, the Commission has ample legal authority to redistribute recaptured 2 GHz MSS spectrum to TMI/TerreStar and ICO under Section 316 of the Communications Act without a notice-and-comment rulemaking proceeding under the APA. Section 316(a) of the Communications Act authorizes the Commission to modify "any station license … if, in the judgment of the Commission such action will promote the public interest, convenience, and necessity."[47]

[47] 47 U.S.C. § 316(a). In the First and Second Redistribution Notices, the Commission did not apply the spectrum redistribution procedures announced in the April 2003 *Licensing Reform Order*, but rather solely relied on Section 316 of the Act. *See Amendment of the Commission's Space Station Licensing Rules*, IB Docket 02-34, 18 FCC Rcd. 10760, 10788-10790 ¶¶ 61-65 (2003) ("*Licensing Reform Order*"), *codified at* 47 C.F.R. § 25.157(g). In the *Licensing Reform Order*, the Commission established a system under which any spectrum surrendered by an "NGSO-like" licensee – a term which includes MSS – would be distributed *pro rata* among the remaining NGSO-like licensees in the same band as the surrendering licensee. Despite its recognition of the benefits of additional spectrum for MSS, the Commission found that it would only apply the redistribution procedure on a *de facto* basis if a "sufficient number of licensees" remain to make "reasonably efficient use of the frequency band." The Commission held, however, that parties may rebut this presumption by providing convincing evidence that "allowing only two licensees in the frequency band will result in extraordinarily large, cognizable and non-speculative efficiencies." *Id*. As described below, assigning of the remaining available spectrum to the two existing 2 GHz MSS licensees would produce extraordinarily large, cognizable and non-speculative efficiencies. Accordingly, if the Commission were to apply the *Licensing Reform Order* to the 2 GHz mobile satellite service, the outcome would be the same – the available spectrum would be reassigned to the existing MSS licensees.

Given the public interest basis for the agency's action,[48] the Commission may properly rely on this statutory provision here and prior FCC actions regarding the assignment of MSS spectrum do not suggest otherwise.

First, the Commission's resolution of Iridium's spectrum rights in the Big LEO band is plainly distinguishable. The Commission appropriately opened a notice-and-comment rulemaking to resolve the assignment of forfeited Big LEO spectrum and, ultimately, to modify the license of Iridium because, in contrast to the 2 GHz MSS band, the Commission had not adopted a clear policy on how to reassign surrendered Big LEO spectrum.[49] That is not the case for the 2 GHz MSS where, at least since 2000, there has been a general presumption that reassignment to any remaining licensees is in the public interest. TMI/TerreStar has documented this precedent at length in IB Docket No. 05-220.[50]

Second, the Commission's modification of the Nextel license under Section 316, following a rulemaking proceeding, is likewise easily distinguishable given the *sui generis* nature of Nextel's proposed license modification and the absence of any prior policy to govern the matter. Similarly, the FCC's reliance on a rule making proceeding to provide a public interest record for modifying MSV's L-band license also stemmed from the absence of a governing policy regarding MSV's use of the lower L-band spectrum the agency's original licensing decisions, which contemplated that

48 *See* Sections I and II, *supra*.

49 *See Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Bands,* Report & Order and Notice of Proposed Rulemaking, 18 FCC Rcd. 1962, 2087-88 ¶¶ 261-63 (2003) ("Big LEO NPRM").

50 *See* Reply Comments of TMI/TerreStar, IB Docket No. 05-220, at 2 (filed July 25, 2005) (describing history of reallocations of recaptured MSS spectrum to existing MSS licensees in the 2 GHz band pursuant to Section 316 of the Act).

licensees would operate solely in the L-band.[51] Here, by comparison, the FCC has previously used a rulemaking proceeding to decide the frequencies to be licensed for the 2 GHz MSS and is merely determining the extent to which unlicensed spectrum should be reassigned.

Third, a full-blown rulemaking process is uncalled for here because the Commission has already sought guidance on exactly the same MSS spectrum reassignment issue in the landmark *Licensing Reform* rulemaking proceeding.[52] There, following extensive public comment,, the Commission established a system under which any spectrum surrendered by an "NGSO-like" licensee – a term which includes MSS[53] – would be distributed *pro rata* among the remaining NGSO-like licensees in the same band as the surrendering licensee. It specifically found that this approach "would likely put the spectrum into use more quickly than any other alternative."[54] The Commission explained that this policy would apply on a *de facto* basis if a "sufficient number of licensees" remain to make "reasonably efficient use of the frequency band"[55] and "presume[ed]" that a sufficient number of licensees would be three.[56]

Importantly, however, the Commission made clear that it would not follow this presumption, and would instead redistribute the surrendered spectrum to the remaining two licensees in the band, if presented with evidence that "allowing only two

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51 *See Establishing Rules and Policies for the Use of Spectrum for Mobile satellite Service in the Upper and Lower L-Band,* 17 FCC Rcd 2704 (2002).

52 *Amendment of the Commission's Space Station Licensing Rules and Policies*, IB Docket No. 02-34.

53 *Licensing Reform Order*, 18 FCC Rcd. at 10774.

54 *Id.* at 10778.

55 *Id.*

56 *Id.*

licensees in the frequency band will result in extraordinarily large, cognizable and non-speculative efficiencies."[57] That is the case here as demonstrated in Section I, *supra*, and in the evidence docketed by TMI/TerreStar prior to the commencement of this proceeding.[58] Consequently, based on the Commission's prior reliance on a rulemaking proceeding to explore the general policy questions regarding the reassignment of MSS spectrum, and the information available to it, the agency plainly has the discretion to initiate this adjudicatory docket to resolve the issues before it.

The Commission likewise used appropriate legal discretion to divide the 2 GHz MSS spectrum reassignment issues into two dockets – IB Docket Nos. 05-220 and 05-221 – and is under no obligation to consolidate them now, as some parties contend.[59] It is well established that the FCC has wide latitude to order its own docket and need not resolve all issues at once, even though related so long as it explains its course (as here) and acts reasonably.[60] Here it was quite reasonable for the FCC to divide the spectrum reassignment issues as it did because the reassignment of 2 x 2.67 MHz to each remaining licensee was plainly required by the agency's established polices whereas the reassignment of an additional 2 x 3.34 MHz arguably raised additional public interest issues in light of the Satellite Licensing Reform Order.

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57 *Id.*

58 Letter from Gregory C. Staple, Vinson & Elkins, Counsel for TMI, and Jonathan D. Blake, Covington & Burling, Counsel for TerreStar, to Donald Abelson, Chief, International Bureau (April 19, 2005).

59 *See, e.g.,* Reply Comments of CTIA, IB Docket No. 05-220, at 4-5 (filed July 25, 2005); Reply Comments of Intel Corp., IB Docket No. 05-220, at 1 (filed July 25, 2005).

60 *See, e.g.*, *Telecommunications Resellers Assoc. v. FCC*, 141 F.3d 1193, 1196 (D.C. Cir. 1998) (upholding FCC's right to defer to a separate proceeding the interconnection issues raised by petitioner); *Cable & Wireless P.L.C. v. FCC*, 166 F.3d 1224 (D.C. Cir 1999) (upholding piecemeal changes to the Commission's International Settlements Policy).

As such, while the impact of IB Dockets 05-220 and 221 on the mobile industry may be linked, the two dockets involve distinctly separate legal and policy issues, and hence were properly relegated to different dockets. Accordingly, the FCC properly and within its discretion segregated these issues into two distinct dockets.

CONCLUSION

The Commission should promptly distribute the remaining 2 x 6.67 MHz of 2 GHz MSS spectrum on a *pro rata* basis to TMI/TerreStar and ICO. Such action will ensure that these licensees can provide the maximum benefits of next-generation MSS/ATC networks to the consumer market, first responders, homeland security, and rural America.

Respectfully submitted,

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July 29, 2005

Comments of TMI and TerreStar
WT Docket No. 05-221

EXHIBIT A: Technical Appendix

Technical Appendix

Introduction

The purpose of this appendix is to describe the public interest benefits of assigning to TerreStar 2 x 10 MHz rather than 2 x 6.7 MHz. The main benefits of the additional spectrum are: (i) it will permit TerreStar to provide substantially more service to the public and (ii) it will permit TerreStar to deploy advanced air interfaces that, in the event of an emergency, can be used to concentrate maximum data throughput into a single area of the country.

The defining characteristic of TerreStar's groundbreaking system design is its ability to provide broadband satellite service to user equipment that is as small, lightweight, and inexpensive as today's cellular and PCS equipment and has similar RF characteristics in terms of its output power and receiver sensitivity. To accomplish this, TerreStar is committed to constructing a satellite with a very large antenna (18 meters in diameter) that will deliver an Aggregate Equivalent Isotropic Radiated Power (AEIRP) of 80 dBW. This is five times more transmit power than Thuraya (the most advanced satellite launched to date) and 16 times more transmit power than Inmarsat-4 (the Thuraya AEIRP is 73 dBW; the I-4 AEIRP is 68 dBW).[1] Of critical importance to the economics of the TerreStar design is that this additional power is essentially free.[2] Once we committed to using an 18 meter antenna to provide service to small, lightweight handsets, the additional cost of higher power amplifiers was nominal.[3]

TerreStar is committed to building a system that will provide a full complement of communications services by satellite, including circuit-switched voice, Push-to-Talk, Short Message Service, and on-demand broadband multimedia content. As such, the TerreStar network, including both the satellite and ancillary terrestrial components, is being developed to accommodate one or more broadband air interface protocols to be able to provide high-speed packet-switched communications to users everywhere in the United States. Both the satellite and the ATC will use substantially the same broadband

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[1] As the attached letters from Hughes Network Systems (HNS) and Rydbeck Consulting indicate, if the MSS satellite is sufficiently powerful, then the manufacturing cost-increment to add satellite capability to an end user device is contained within $5. *See* Exhibits A and B. TerreStar notes that the HNS letter was addressed to Mobile Satellite Ventures LP before TerreStar was spun off from MSV.

[2] *See* Letter from Space Systems/Loral (attached hereto as Exhibit 3).

[3] While Inmarsat claims that TerreStar could have designed a satellite with less power, this ignores the significant public interest benefits of TerreStar's ability to offer small, lightweight, and inexpensive equipment to public safety users and consumers in rural areas using its proposed satellite. *See* Comments of Inmarsat, IB Docket No. 05-220 (July 13, 2005), at 22-23. If Inmarsat had its way, public safety organizations, residents of rural areas, and other users of mobile satellite services would forever be relegated to expensive, bulky terminals.

air interface protocols to simplify and lower the cost of producing integrated satellite/terrestrial user equipment.[4]

A more specific description of the relevant technical parameters follows:

- Satellite AEIRP = 80 dBW
- Satellite G/T = 20.5 dB/°K
- Transparency class user equipment: $EIRP_{MAX}$ = -12 dBW; G/T = -31 dB/°K; linearly-polarized antenna with gain of -4 dBi
- First responder's hand-held user equipment: $EIRP_{MAX}$ = -7 dBW; G/T = -26 dB/°K; circularly-polarized antenna with gain of 1 dBi
- First responder's vehicular-mounted user equipment: $EIRP_{MAX}$ = 0 dBW; G/T = -22 dB/°K; circularly-polarized antenna with gain of 5 dBi
- First responder's lap-top portable user equipment: $EIRP_{MAX}$ = 3 dBW; G/T = -20 dB/°K; circularly-polarized antenna with gain of 7 dBi

Each class of user equipment will contain MSS/ATC integrated capability and with the exception of elements that make each class unique, such as, Power Amplifier (PA) size, antenna configuration/gain, battery size, encryption algorithm, mechanical design and/or man-machine interface, one common electrical transceiver design will be used for all to thereby create economies of scale in components count and Printed Circuit Board (PCB) manufacturing.

1. Access to 2 x 10 MHz Permits TerreStar to Provide Substantially More Satellite Service

Despite the claims of Inmarsat and others, an assignment of 2 x 10 MHz is essential for TerreStar to provide critical satellite services to the public.[5] TerreStar's system is designed to greatly increase the number of consumers that can use the satellite service. With access to 2 x 10 MHz of spectrum, depending on the mix of user equipment and the services they use, we expect to be able to serve up to 5 million subscribers without regard to the ancillary terrestrial component. This is achieved largely through the deployment of such a high-powered satellite. Unfortunately, however, to achieve this capacity requires sufficient spectrum – otherwise, the extra power is wasted and the system's capacity reduced. As discussed in more detail below, depending on the mix of users, with access to 2 x 10 MHz the TerreStar system will be able to serve almost twice as many users as it can serve with access to 2 x 6.7 MHz.

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[4] Thus, despite Inmarsat's claim, there are legitimate reasons for why an MSS operator would want to use the same air interface protocol for the satellite and the ATC. *See* Comments of Inmarsat, IB Docket No. 05-220 (July 13, 2005), at 23.

[5] *See* Comments of Inmarsat, IB Docket No. 05-220 (July 13, 2005), at 15; Comments of CTIA at 4-5; Comment of T-Mobile, IB Docket No. 05-220 (July 13, 2005), at 3; Reply Comments of Cingular, IB Docket No. 05-220 (July 13, 2005), at 3.

In accordance with TerreStar's spectrum-efficient hybrid system design, a frequency reuse cluster size comprising more than one cell is used over the satellite return service links.[6] For example, a three-cell frequency reuse cluster size may be used. As such, the set of available return-link frequencies, {F}, may be segmented into three distinct sets $\{F_1\}$, $\{F_2\}$, and $\{F_3\}$, such that $\{F_1\} + \{F_2\} + \{F_3\} = \{F\}$, and distributed over the respective three cells of the frequency reuse cluster. A satellite cell that is using the frequency set $\{F_1\}$, for example, and contains an ATC within its geographic footprint may allow that ATC to serve users using the frequencies of set $\{F_2\}$ and/or $\{F_3\}$, thereby avoiding co-channel interference from the ATC. The adjacent satellite cells receiving satellite traffic on $\{F_2\}$ and $\{F_3\}$ will experience a level of ATC-induced interference. However, interference cancellation at the satellite gateway may be used to create satellite antenna nulls in the direction of the ATC to thereby reduce the ATC-induced interference to levels that are non-harmful. To achieve this, the TerreStar satellite will not be configured to form beam patterns in space. Instead, the signals that are intercepted by the plurality of return service link antenna feed elements will be transferred to the ground (to one or more satellite gateways) where they will be combined optimally by a Ground-Based Beam Former to form the optimum (in the Minimum Mean-Squared Error sense) satellite beam (antenna pattern), for each user, maximizing desired signal energy while minimizing noise and interference, including ATC-induced interference.

Despite CTIA's claim, a frequency reuse cluster size comprising a number of satellite cells that is greater than one, does not mean that the satellite has been forced to be less spectrally efficient in order to accommodate the ATC.[7] In fact, the spectral efficiency of the satellite may increase as the reuse cluster size increases from one cell (immediate frequency reuse) to three cells, and even to four or five cells. This is a consequence of the inter-beam isolation being very poor for immediate frequency reuse, substantially limiting the loading of a carrier, and improving significantly for non-immediate frequency reuse cluster sizes allowing much greater loading of the same carrier. For the TerreStar satellite design, the average Carrier-to-Interference (C/I) ratio as a function of reuse cluster size is summarized in Table 1 below.[8]

Table 1 – Average C/I over CONUS (dB)

Frequency Reuse Cluster Size	Average Received C/I (dB)
1	-8.8
3	1.1
4	2.1
5	4.5
7	10.5
9	13.3

[6] The satellite forward service links may be based on immediate frequency reuse.

[7] Comments of CTIA, IB Docket No. 05-220 (July 13, 2005), at 12.

[8] This data has been derived from design parameters provided by TerreStar's satellite manufacturer Space Systems/Loral.

The attached link budgets illustrate the impact of inter-beam interference and reuse cluster size on satellite capacity (see Supplements A – E). The air interface protocol is assumed to be cdma2000 but it could be another protocol with similar relevant characteristics, such as WiMAX. Assuming transparent user devices, a spectrum allocation of 2 x 6.67 MHz, and immediate frequency reuse, the satellite is power limited (see Supplement A). Only 5 users per cdma2000 carrier can be supported owing to significant adjacent beam interference. Increasing the frequency reuse cluster size to 5 transforms the satellite to being spectrally limited and able to support 50% more users (see Supplement B). Supplement C illustrates that with a spectrum allocation of 2 x 10 MHz the satellite is able to serve an additional 44% more users. Stating this differently, with 2 x 10 MHz of spectrum, the satellite is able to use all of its power to serve users whereas with 2 x 6.67 MHz only 56% of the satellite power is useable. The additional spectrum will also increase TerreStar's *trunking* efficiency, for both the satellite and ATC, thereby allowing TerreStar to further increase its spectral efficiency.

Supplement D illustrates that in serving first responder's equipment, the satellite remains severely spectrally limited, when providing voice services, even with 2 x 10 MHz of spectrum, owing to the greater G/T value of the user equipment. In providing data services, however, the satellite will expend more power, owing to the higher E_b/N_0 requirement of data, becoming substantially balanced, as is illustrated in Supplement E. Supplement E illustrates that with user equipment that is configured for broadband data services (as may be the case with first responder's vehicular-mounted user equipment) the TerreStar satellite operating with 2 x 10 MHz of spectrum will be able to provide a throughput of 1.28 Mbps per four cell frequency reuse cluster and an overall CONUS-wide throughput of 90 Mbps. As can be seen from the analysis of Supplement E, there are 10 users per cdma2000 carrier each receiving 16 kbps (or one user receiving 160 kbps). Since 2 x 10 MHz of spectrum allows for a 4-cell frequency reuse cluster size, with two cdma2000 carriers allocated in each cell, the per cell forward link capacity is:

(10 users/carrier) x (16 kbps/user) x (2 carriers/cell) = 320 kbps/cell.

The 4-cell frequency reuse cluster forward link capacity is:

(320 kbps/cell) x (4 cells/frequency reuse cluster) = 1280 kbps/frequency reuse.

The CONUS-wide footprint of TerreStar comprises 71 frequency reuse clusters (assuming the frequency reuse cluster size is four cells). Thus, the CONUS-wide data capacity of TerreStar is:

(1280 kbps/frequency reuse) x (71 reuses over CONUS) = **90.88 Mbps**

The above analysis would be similar for the previously referenced first responder's lap-top portable user equipment.

Contrary to the claims of Inmarsat and terrestrial wireless carriers, the addition of an ancillary terrestrial component does mean that the system needs more spectrum than otherwise.[9] Unless an operator invokes band segmentation, wherein only a portion of the available spectrum is allocated to the MSS and the rest is reserved for ATC, the terrestrial facilities do not reduce the spectrum available for satellite service. Instead, they add to the overall spectrum efficiency. The Commission has recognized this important benefit.[10] An optimally designed hybrid MSS/ATC network is one that uses its entire spectrum pool to serve customers via a space segment and, at the same time, the spectrum is reused by the ATC, in coordination with the space segment, to serve customers in populous areas where satellite connectivity is unreliable. TerreStar is developing such an optimum hybrid system based on patented technology that it has licensed from Mobile Satellite Ventures LP (MSV).

2. Access to 2 x 10 MHz Will Permit TerreStar to Deploy Advanced Air Interfaces That Would Be Particularly Useful in a Localized Emergency

The previous section evaluated the forward link capacity of the TerreStar satellite assuming cdma2000 as the air interface protocol. The analysis of Supplement E showed that, with 2 x 10 MHz of spectrum, the TerreStar satellite has enough AEIRP to provide 90 Mbps, CONUS-wide, to devices having a receiver G/T of -22 dB/°K. During an emergency, however, first responder traffic may be concentrated regionally, for example, over a geographic area corresponding to a four-cell frequency reuse cluster. As such, if the TerreStar satellite were to use an air interface protocol such as cdma2000, it would be limited to providing an instantaneous data throughput of no more than 1.28 Mbps over such a geographic region. The limited carrier bandwidth of cdma2000 and its relatively low bits/sec/Hz capability would be the limiting factors. To overcome this problem, TerreStar needs the flexibility to be able to deploy a more advanced 4G air interface protocol which can be based on a much broader carrier bandwidth. One illustrative example is the 802.16e (OFDM/OFDMA) protocol, providing a carrier bandwidth of 10 MHz, capable of a variable-element modulation alphabet (comprising BPSK, QPSK, 16 QAM, and 64 QAM), and capable of providing regionally (over the geographic area of the four-cell frequency reuse cluster) up to 30 Mbps of data throughput.[11] This is but one

[9] *See* Comments of Inmarsat, IB Docket No. 05-220 (July 13, 2005), at 19; Comments of CTIA, IB Docket No. 05-220 (July 13, 2005), at 9; Comment of T-Mobile, IB Docket No. 05-220 (July 13, 2005), at 4 n.11; Reply Comments of Cingular, IB Docket No. 05-220 (July 25, 2005), at 5.

[10] *See Flexibility for Delivery of Communications by MSS Providers, Report and Order*, IB Docket No. 01-185, 18 FCC Rcd 1962 (February 10, 2003) at ¶¶ 1, 21-22 (noting how ATC will increase spectrum efficiency).

[11] Inmarsat notes that its BGAN service can achieve data rates of 2.5 bps/Hz, which would enable Terrestar to achieve data rates of approximately 10 Mbps in its assigned 4 MHz. *See* Reply Comments of Inmarsat, IB Docket No. 05-220 (July 25, 2005), at 7. This is far from sufficient to achieve the mobile broadband needs of public safety organizations, particularly those requiring the ability to receive and/or transmit live video and other data related to a disaster scene.

example of emerging 4G air interface protocols that TerreStar is currently considering for its system. The key point is that, having allocated spectrum for MSS given the vital public interest benefits of this service, the Commission should not preclude existing operators from taking advantage of technological trends that will redound to the benefit of MSS users, particularly those in the public safety community.

It is important to appreciate that the maximum data reception capability of a satellite terminal depends on two fundamental factors: (a) on the bandwidth of the carrier being transmitted by the satellite, and (b) on the value of E_b/N_0 at the terminal's data detector (which depends on the carrier power being radiated by the satellite). Also, it is important to appreciate that as a satellite transmitter increases its output power, the transmitter may utilize a larger element alphabet, thereby increasing the number of bits communicated per transmitted symbol while maintaining the value of E_b/N_0 at the receiver at an acceptable level. The combination of a maximally broadband carrier, the ability to increase the level of radiated power, and the ability to use a variable modulation alphabet, provides maximum flexibility for delivering high-speed data, to one or more user devices, on demand, and in accordance with the user device profile and technical characteristics thereof. TerreStar is being developed with such flexibility and needs the spectrum enabler to deliver the asset to the public.

Supplement A

Capacity of Satellite using 2 x 6.67 MHz of Spectrum to Serve Transparency Users with Immediate Frequency Reuse

- **Satellite AEIRP: 80 dBW**
- **Satellite G/T: 20.5 dB/°K**
- **Air Interface Protocol: cdma2000 1X**
- **Service: 4.8 kbps voice**
- **Transparency User Equipment: $EIRP_{MAX}$ = -12 dBW; G/T = -31 dB/°K; linearly-polarized antenna with gain of -4 dBi**

Forward Link Budget

Frequency reuse factor 1

	Common Parameters	<== Channel-specific ==> Sync. Channel	Paging Channel	Traffic Channel	Units
CHANNEL PARAMETERS:					
Total number of chnls. per forward carrier:		1	3	5	
Channel info. rate (for calculating Ebi):		1200.0	4800.0	4800.0	bps
Transmit duty factor or voice activity fac.:		0.0	0.0	-4.0	dB
Forward carrier chip rate:	1.2288				Mcps
Pct. forward cxr. pwr. allocated to Pilot Ch.:	20.0%				
Total number of co-frequency spot beams:	285				
DOWNLINK Ebi/N0 (thermal):					
Satellite EIRP per channel:		39.0	45.0	45.0	dBW
Path loss:	-191.0				dB
Polarization mismatch loss (CP to LP):	-3.0				dB
Fading and blockage allocation	**-6.0**				**dB**
User terminal G/T:	-31.0				dB/K
Boltzmann's constant:	-228.6				dBW/Hz.K
Downlink Ebi/N0:		**5.8**	**5.8**	**5.8**	**dB**
UPLINK Ebi/N0 (thermal):					
E/S EIRP to Satellite EIRP conversion:	5.0				dB
Earth station EIRP per channel:		44.0	50.0	50.0	dBW
Uplink path loss:	-206.7				dB
Uplink rain loss (assume site diversity):	-6.0				dB
Satellite G/T:	14.0				dB/K
Boltzmann's constant:	-228.6				dBW/Hz.K
Uplink Ebi/N0:		**43.1**	**43.1**	**43.1**	**dB**
INTRA-BEAM SELF INTERFERENCE (due to imperfect rejection of Walsh codes):					
Orthogonality impairment factor:	8.0				dB
Forward carrier EIRP (time-averaged):	52.8				dBW
CDMA processing gain:		30.1	24.1	24.1	dB
Self-Interference Ebi/I0 (multi-path):		**24.3**	**24.3**	**24.3**	**dB**
INTER-BEAM INTERFERENCE:					
Sat. antenna adjacent spot beam discrimination:	15.5				dB
Total number of interfering co-freq. carriers:	284				
Interfering carrier EIRP (time-avg.):	53.2				dBW
CDMA processing gain:		30.1	24.1	24.1	dB
System loading		43%	43%	43%	
Adjacent Beam Interference Ebi/I0:		**10.6**	**10.6**	**10.6**	**dB**
TOTAL:					
TOTAL Ebi/(N0 + I0):		**4.5**	**4.5**	**4.5**	**dB**
Min. reqd. Ebi/N0 (1% frame error rate):	3.5				dB
Implementation Loss Margin		**1.0**	**1.0**	**1.0**	**dB**

Return Link Budget

Frequency reuse factor 1

INFORMATION RATE (for calculating Ebi):			**INTRA-BEAM SELF INTERFERENCE Ebi/I0:**		
User data plus in-band signaling:	**4.8**	kbps	Num. Interfering Terminals in Beam	4	
			Imperfect Power Control Factor	0.5	
CHANNEL/SATELLITE LOADING:			Chip rate:	1228.8	kcps
Simultaneous users per carrier:	5		Processing Gain:	256.0	
Total number of co-freq. beams:	285				
			Ebi/I0 due to processing gain only:	**14.9**	**dB**
UPLINK Ebi/N0 (thermal):					
Terminal SSPA Output Power	-6.0	dBW			
			2-Polarization recombination gain	1.0	dB
Diplexer/Feed Loss	-1.0	dB	2-satellite diversity improvement:	0.0	dB
Terminal Tx Antenna Gain	**-4.0**	dBi	Voice activity improvement factor:	2.0	dB
Reduction in Ebi due to pilot power:	-1.0	dB	**Self-Jamming Ebi/I0 (intra-beam):**	**17.9**	**dB**
Terminal Uplink EIRP:	**-12.0**	dBW	**INTER-BEAM INTERFERENCE Ebi/I0**		
			Avg. S/C antenna discrimination to adj. beams:	**15.5**	dB
U/L Path Loss	-190.3	dB	Total interbeam C/I	-9.0	
Allocated fading and blockage loss	**-6.0**	dB	Number of co-freq. interfering beams:	284	
			Number of simultaneous users per beam:	5.0	
S/C G/T:	20.5	dB/K	Processing Gain:	256.0	
2-Polarization recombination gain	**1.0**	dB	Imperfect Power Control Factor	-3.0	dB
2-satellite diversity improvement	0.0	dB			
			Ebi/I0 due to processing gain only:	**4.9**	**dB**
Uplink Ebi/N0:	**5.0**	**dB**			
			2-satellite diversity improvement:	0.0	dB
DOWNLINK Ebi/N0 (thermal):			2-Polarization recombination gain	1.0	dB
Reston Hub E/S G/T	36.5	dB/K			
Total S/C downlink EIRP	47.0	dBW	Voice activity improvement factor:	2.0	dB
Total return downlink bandwidth	250.0	MHz	System loading	43%	
Bandwidth per CDMA channel	1.25	MHz	**Aggregate Ebi/I0 fm. all adjacent beams:**	**11.7**	**dB**
Num. simultaneous users per channel	5.0				
Satellite EIRP per user per return carrier:	**17.0**	**dBW**	**SUMMARY:**		
			U/L Ebi/N0 (thermal):	5.0	dB
Rain loss (w/ site diversity)	-6.0	dB	Intra-beam Self-Jamming Ebi/I0:	17.9	dB
			D/L Ebi/N0 (thermal):	34.1	dB
Path loss	-205.2	dB	Adj. spot beam interference Ebi/I0	11.7	dB
2-satellite diversity improvement - D/L:	0	dB	**TOTAL Ebi/(N0 + I0):**	**4.0**	**dB**
Boltzmann's constant	-228.6	dBW/Hz.K	Min. reqd. Ebi/N0 (1% frame error rate):	3.5	dB
			Implementation Loss Margin	**0.5**	**dB**
Downlink Ebi/N0:	**34.1**	**dB**			

Capacity Limits

Capacity Limit Based on Satellite Power:		
Average fading and blockage	5	dB
Satellite antenna gain:	48.0	dBi
Sat. SSPA total output power:	33.0	dBW
Satellite feed losses	-1.0	dB
Satellite aggregate EIRP	80.0	dBW
2-satellite operation:	0.0	dB
% sat. EIRP available for CDMA:	100.0%	
Total available satellite EIRP:	**80.0**	dBW
EIRP per forward carrier:	52.2	dBW
Total # forward cxrs. supported:	**607**	
Max. users per carrier:	5	
Total # simultaneous voice ccts.:	**3,035**	
Capacity Limit Based on Available Banwidth		
Available bandwidth	**6.67**	MHz
Frequency reuse factor	**1**	
No. of spot beams	**285**	
No. of frequency reuse clusters	285	
No. of frequency sets in each cluster	5	
No. of (distinct) frequencies in each cluster	5	
Occupied bandwidth	6.25	MHz
No. of carriers in total system	**1425**	
Max. users per carrier:	5	
Total # simultaneous voice ccts.:	**7,125**	

Supplement B

Capacity of Satellite using 2 x 6.67 MHz of Spectrum to Serve Transparency Users with a Five Cell Frequency Reuse

- **Satellite AEIRP: 80 dBW**
- **Satellite G/T: 20.5 dB/°K**
- **Air Interface Protocol: cdma2000 1X**
- **Service: 4.8 kbps voice**
- **Transparency User Equipment: $EIRP_{MAX}$ = -12 dBW; G/T = -31 dB/°K; linearly-polarized antenna with gain of -4 dBi**

Forward Link Budget
Five Cell Frequency Reuse Cluster Size

	Common Parameters	Sync. Channel	Paging Channel	Traffic Channel	Units
		<== Channel-specific	==>		
CHANNEL PARAMETERS:					
Total number of chnls. per forward carrier:		1	3	16	
Channel info. rate (for calculating Ebi):		1200.0	4800.0	4800.0	bps
Transmit duty factor or voice activity fac.:		0.0	0.0	-4.0	dB
Forward carrier chip rate:	1.2288				Mcps
Pct. forward cxr. pwr. allocated to Pilot Ch.:	20.0%				
Total number of co-frequency spot beams:	57				
DOWNLINK Ebi/N0 (thermal):					
Satellite EIRP per channel:		38.0	44.0	**44.0**	dBW
Path loss:	-191.0				dB
Polarization mismatch loss (CP to LP):	-3.0				dB
Fading and blockage allocation	**-6.0**				**dB**
User terminal G/T:	-31.0				dB/K
Boltzmann's constant:	-228.6				dBW/Hz.K
Downlink Ebi/N0:		**4.8**	**4.8**	**4.8**	**dB**
UPLINK Ebi/N0 (thermal):					
E/S EIRP to Satellite EIRP conversion:	5.0				dB
Earth station EIRP per channel:		43.0	49.0	49.0	dBW
Uplink path loss:	-206.7				dB
Uplink rain loss (assume site diversity):	-6.0				dB
Satellite G/T:	14.0				dB/K
Boltzmann's constant:	-228.6				dBW/Hz.K
Uplink Ebi/N0:		**42.1**	**42.1**	**42.1**	**dB**
INTRA-BEAM SELF INTERFERENCE (due to imperfect rejection of Walsh codes):					
Orthogonality impairment factor:	8.0				dB
Forward carrier EIRP (time-averaged):	54.6				dBW
CDMA processing gain:		30.1	24.1	24.1	dB
Self-Interference Ebi/I0 (multi-path):		**21.5**	**21.5**	**21.5**	**dB**
INTER-BEAM INTERFERENCE:					
Sat. antenna adjacent spot beam discrimination:	22.0				dB
Total number of interfering co-freq. carriers:	56				
Interfering carrier EIRP (time-avg.):	54.8				dBW
CDMA processing gain:		30.1	24.1	24.1	dB
System loading		100%	100%	100%	
Adjacent Beam Interference Ebi/I0:		**17.8**	**17.8**	**17.8**	**dB**
TOTAL:					
TOTAL Ebi/(N0 + I0):		**4.5**	**4.5**	**4.5**	**dB**
Min. reqd. Ebi/N0 (1% frame error rate):	3.5				dB
Implementation Loss Margin		**1.0**	**1.0**	**1.0**	**dB**

Return Link Budget

Five Cell Frequency Reuse Cluster Size

INFORMATION RATE (for calculating Ebi):		
User data plus in-band signaling:	**4.8**	kbps
CHANNEL/SATELLITE LOADING:		
Simultaneous users per carrier:	16	
Total number of co-freq. beams:	57	
UPLINK Ebi/N0 (thermal):		
Terminal SSPA Output Power	-6.0	dBW
Diplexer/Feed Loss	-1.0	dB
Terminal Tx Antenna Gain	**-4.0**	dBi
Reduction in Ebi due to pilot power:	-1.0	dB
Terminal Uplink EIRP:	**-12.0**	dBW
U/L Path Loss	-190.3	dB
Allocated fading and blockage loss	**-6.0**	dB
S/C G/T:	20.5	dB/K
2-Polarization recombination gain	**1.0**	dB
2-satellite diversity improvement	0.0	dB
Uplink Ebi/N0:	**5.0**	**dB**
DOWNLINK Ebi/N0 (thermal):		
Reston Hub E/S G/T	36.5	dB/K
Total S/C downlink EIRP	47.0	dBW
Total return downlink bandwidth	250.0	MHz
Bandwidth per CDMA channel	1.25	MHz
Num. simultaneous users per channel	16.0	
Satellite EIRP per user per return carrier:	**11.9**	**dBW**
Rain loss (w/ site diversity)	-6.0	dB
Path loss	-205.2	dB
2-satellite diversity improvement - D/L:	0	dB
Boltzmann's constant	-228.6	dBW/Hz.K
Downlink Ebi/N0:	**29.0**	**dB**

INTRA-BEAM SELF INTERFERENCE Ebi/I0:		
Num. Interfering Terminals in Beam	15	
Imperfect Power Control Factor	0.5	
Chip rate:	1228.8	kcps
Processing Gain:	256.0	
Ebi/I0 due to processing gain only:	**9.2**	**dB**
2-Polarization recombination gain	1.0	dB
2-satellite diversity improvement:	0.0	dB
Voice activity improvement factor:	2.0	dB
Self-Jamming Ebi/I0 (intra-beam):	**12.2**	**dB**
INTER-BEAM INTERFERENCE Ebi/I0		
Avg. S/C antenna discrimination to adj. beams:	**22.0**	dB
Total interbeam C/I	4.5	
Number of co-freq. interfering beams:	56	
Number of simultaneous users per beam:	16.0	
Processing Gain:	256.0	
Imperfect Power Control Factor	-3.0	dB
Ebi/I0 due to processing gain only:	**13.4**	**dB**
2-satellite diversity improvement:	0.0	dB
2-Polarization recombination gain	1.0	dB
Voice activity improvement factor:	2.0	dB
System loading	100%	
Aggregate Ebi/I0 fm. all adjacent beams:	**16.4**	**dB**
SUMMARY:		
U/L Ebi/N0 (thermal):	5.0	dB
Intra-beam Self-Jamming Ebi/I0:	12.2	dB
D/L Ebi/N0 (thermal):	29.0	dB
Adj. spot beam interference Ebi/I0	16.4	dB
TOTAL Ebi/(N0 + I0):	**4.0**	**dB**
Min. reqd. Ebi/N0 (1% frame error rate):	3.5	dB
Implementation Loss Margin	**0.5**	**dB**

Capacity Limits

Capacity Limit Based on Satellite Power:		
Average fading and blockage	5	dB
Satellite antenna gain:	48.0	dBi
Sat. SSPA total output power:	33.0	dBW
Satellite feed losses	-1.0	dB
Satellite aggregate EIRP	80.0	dBW
2-satellite operation:	0.0	dB
% sat. EIRP available for CDMA:	100.0%	
Total available satellite EIRP:	**80.0**	dBW
EIRP per forward carrier:	53.8	dBW
Total # forward cxrs. supported:	**416**	
Max. users per carrier:	16	
Total # simultaneous voice ccts.:	**6,656**	
Capacity Limit Based on Available Banwidth		
Available bandwidth	**6.67**	MHz
Frequency reuse factor	5	
No. of spot beams	**285**	
No. of frequency reuse clusters	57	
No. of frequency sets in each cluster	1	
No. of (distinct) frequencies in each cluster	5	
Occupied bandwidth	6.25	MHz
No. of carriers in total system	**285**	
Max. users per carrier:	16	
Total # simultaneous voice ccts.:	**4,560**	

Supplement C

Capacity of Satellite using 2 x 10 MHz of Spectrum to Serve Transparency Users with a Four Cell Frequency Reuse

- **Satellite AEIRP: 80 dBW**
- **Satellite G/T: 20.5 dB/°K**
- **Air Interface Protocol: cdma2000 1X**
- **Service: 4.8 kbps voice**
- **Transparency User Equipment: $EIRP_{MAX}$ = -12 dBW; G/T = -31 dB/°K; linearly-polarized antenna with gain of -4 dBi**

Forward Link Budget
Four Cell Frequency Reuse Cluster Size

	Common Parameters	<== Channel-specific ==> Sync. Channel	Paging Channel	Traffic Channel	Units
CHANNEL PARAMETERS:					
Total number of chnls. per forward carrier:		1	3	14	
Channel info. rate (for calculating Ebi):		1200.0	4800.0	4800.0	bps
Transmit duty factor or voice activity fac.:		0.0	0.0	-4.0	dB
Forward carrier chip rate:	1.2288				Mcps
Pct. forward cxr. pwr. allocated to Pilot Ch.:	20.0%				
Total number of co-frequency spot beams:	71				
DOWNLINK Ebi/N0 (thermal):					
Satellite EIRP per channel:		37.8	43.8	**43.8**	dBW
Path loss:	-191.0				dB
Polarization mismatch loss (CP to LP):	-3.0				dB
Fading and blockage allocation	**-6.0**				**dB**
User terminal G/T:	-31.0				dB/K
Boltzmann's constant:	-228.6				dBW/Hz.K
Downlink Ebi/N0:		**4.6**	**4.6**	**4.6**	**dB**
UPLINK Ebi/N0 (thermal):					
E/S EIRP to Satellite EIRP conversion:	5.0				dB
Earth station EIRP per channel:		42.8	48.8	48.8	dBW
Uplink path loss:	-206.7				dB
Uplink rain loss (assume site diversity):	-6.0				dB
Satellite G/T:	14.0				dB/K
Boltzmann's constant:	-228.6				dBW/Hz.K
Uplink Ebi/N0:		**41.9**	**41.9**	**41.9**	**dB**
INTRA-BEAM SELF INTERFERENCE (due to imperfect rejection of Walsh codes):					
Orthogonality impairment factor:	8.0				dB
Forward carrier EIRP (time-averaged):	54.0				dBW
CDMA processing gain:		30.1	24.1	24.1	dB
Self-Interference Ebi/I0 (multi-path):		**21.9**	**21.9**	**21.9**	**dB**
INTER-BEAM INTERFERENCE:					
Sat. antenna adjacent spot beam discrimination:	20.6				dB
Total number of interfering co-freq. carriers:	70				
Interfering carrier EIRP (time-avg.):	54.2				dBW
CDMA processing gain:		30.1	24.1	24.1	dB
System loading		84%	84%	84%	
Adjacent Beam Interference Ebi/I0:		**16.6**	**16.6**	**16.6**	**dB**
TOTAL:					
TOTAL Ebi/(N0 + I0):		**4.2**	**4.2**	**4.2**	**dB**
Min. reqd. Ebi/N0 (1% frame error rate):	3.5				dB
Implementation Loss Margin		**0.7**	**0.7**	**0.7**	**dB**

Return Link Budget

Four Cell Frequency Reuse Cluster Size

INFORMATION RATE (for calculating Ebi):		
User data plus in-band signaling:	**4.8**	kbps
CHANNEL/SATELLITE LOADING:		
Simultaneous users per carrier:	14	
Total number of co-freq. beams:	71	
UPLINK Ebi/N0 (thermal):		
Terminal SSPA Output Power	-6.0	dBW
Diplexer/Feed Loss	-1.0	dB
Terminal Tx Antenna Gain	**-4.0**	dBi
Reduction in Ebi due to pilot power:	-1.0	dB
Terminal Uplink EIRP:	**-12.0**	dBW
U/L Path Loss	-190.3	dB
Allocated fading and blockage loss	**-6.0**	dB
S/C G/T:	20.5	dB/K
2-Polarization recombination gain	**1.0**	dB
2-satellite diversity improvement	0.0	dB
Uplink Ebi/N0:	**5.0**	**dB**
DOWNLINK Ebi/N0 (thermal):		
Reston Hub E/S G/T	36.5	dB/K
Total S/C downlink EIRP	47.0	dBW
Total return downlink bandwidth	250.0	MHz
Bandwidth per CDMA channel	1.25	MHz
Num. simultaneous users per channel	14.0	
Satellite EIRP per user per return carrier:	**12.5**	**dBW**
Rain loss (w/ site diversity)	-6.0	dB
Path loss	-205.2	dB
2-satellite diversity improvement - D/L:	0	dB
Boltzmann's constant	-228.6	dBW/Hz.K
Downlink Ebi/N0:	**29.6**	**dB**

INTRA-BEAM SELF INTERFERENCE Ebi/I0:		
Num. Interfering Terminals in Beam	13	
Imperfect Power Control Factor	0.5	
Chip rate:	1228.8	kcps
Processing Gain:	256.0	
Ebi/I0 due to processing gain only:	**9.8**	**dB**
2-Polarization recombination gain	1.0	dB
2-satellite diversity improvement:	0.0	dB
Voice activity improvement factor:	2.0	dB
Self-Jamming Ebi/I0 (intra-beam):	**12.8**	**dB**
INTER-BEAM INTERFERENCE Ebi/I0		
Avg. S/C antenna discrimination to adj. beams:	**20.6**	dB
Total interbeam C/I	2.1	
Number of co-freq. interfering beams:	70	
Number of simultaneous users per beam:	14.0	
Processing Gain:	256.0	
Imperfect Power Control Factor	-3.0	dB
Ebi/I0 due to processing gain only:	**11.7**	**dB**
2-satellite diversity improvement:	0.0	dB
2-Polarization recombination gain	1.0	dB
Voice activity improvement factor:	2.0	dB
System loading	84%	
Aggregate Ebi/I0 fm. all adjacent beams:	**15.4**	**dB**
SUMMARY:		
U/L Ebi/N0 (thermal):	5.0	dB
Intra-beam Self-Jamming Ebi/I0:	12.8	dB
D/L Ebi/N0 (thermal):	29.6	dB
Adj. spot beam interference Ebi/I0	15.4	dB
TOTAL Ebi/(N0 + I0):	**4.0**	**dB**
Min. reqd. Ebi/N0 (1% frame error rate):	3.5	dB
Implementation Loss Margin	**0.5**	**dB**

Capacity Limits

Capacity Limit Based on Satellite Power:		
Average fading and blockage	5	dB
Satellite antenna gain:	48.0	dBi
Sat. SSPA total output power:	33.0	dBW
Satellite feed losses	-1.0	dB
Satellite aggregate EIRP	80.0	dBW
2-satellite operation:	0.0	dB
% sat. EIRP available for CDMA:	100.0%	
Total available satellite EIRP:	**80.0**	dBW
EIRP per forward carrier:	53.2	dBW
Total # forward cxrs. supported:	**475**	
Max. users per carrier:	14	
Total # simultaneous voice ccts.:	**6,650**	
Capacity Limit Based on Available Banwidth		
Available bandwidth	10	MHz
Frequency reuse factor	**4**	
No. of spot beams	**285**	
No. of frequency reuse clusters	71	
No. of frequency sets in each cluster	2	
No. of (distinct) frequencies in each cluster	8	
Occupied bandwidth	10	MHz
No. of carriers in total system	**568**	
Max. users per carrier:	14	
Total # simultaneous voice ccts.:	**7,952**	

Supplement D

Capacity of Satellite using 2 x 10 MHz of Spectrum to Serve First Responder's Hand-Held User Equipment with a Four Cell Frequency Reuse

- **Satellite AEIRP: 80 dBW**
- **Satellite G/T: 20.5 dB/°K**
- **Air Interface Protocol: cdma2000 1X**
- **Service: 4.8 kbps voice**
- **First Responder's User Equipment: $EIRP_{MAX}$ = -7 dBW; G/T = -26 dB/°K; circularly-polarized antenna with gain of 1 dBi**

Forward Link Budget
Four Cell Frequency Reuse Cluster Size

			<== Channel-specific ==>		
CHANNEL PARAMETERS:	**Common Parameters**	**Sync. Channel**	**Paging Channel**	**Traffic Channel**	Units
Total number of chnls. per forward carrier:		1	3	24	
Channel info. rate (for calculating Ebi):		1200.0	4800.0	4800.0	bps
Transmit duty factor or voice activity fac.:		0.0	0.0	-4.0	dB
Forward carrier chip rate:	1.2288				Mcps
Pct. forward cxr. pwr. allocated to Pilot Ch.:	20.0%				
Total number of co-frequency spot beams:	71				
DOWNLINK Ebi/N0 (thermal):					
Satellite EIRP per channel:		33.4	39.4	39.4	dBW
Path loss:	-191.0				dB
Polarization mismatch loss (CP to LP):	0.0				dB
Fading and blockage allocation	**-9.0**				**dB**
User terminal G/T:	-26.0				dB/K
Boltzmann's constant:	-228.6				dBW/Hz.K
Downlink Ebi/N0:		**5.2**	**5.2**	**5.2**	**dB**
UPLINK Ebi/N0 (thermal):					
E/S EIRP to Satellite EIRP conversion:	5.0				dB
Earth station EIRP per channel:		38.4	44.4	44.4	dBW
Uplink path loss:	-206.7				dB
Uplink rain loss (assume site diversity):	-6.0				dB
Satellite G/T:	14.0				dB/K
Boltzmann's constant:	-228.6				dBW/Hz.K
Uplink Ebi/N0:		**37.5**	**37.5**	**37.5**	**dB**
INTRA-BEAM SELF INTERFERENCE (due to imperfect rejection of Walsh codes):					
Orthogonality impairment factor:	8.0				dB
Forward carrier EIRP (time-averaged):	51.3				dBW
CDMA processing gain:		30.1	24.1	24.1	dB
Self-Interference Ebi/I0 (multi-path):		**20.2**	**20.2**	**20.2**	**dB**
INTER-BEAM INTERFERENCE:					
Sat. antenna adjacent spot beam discrimination:	20.6				dB
Total number of interfering co-freq. carriers:	70				
Interfering carrier EIRP (time-avg.):	51.4				dBW
CDMA processing gain:		30.1	24.1	24.1	dB
System loading		100%	100%	100%	
Adjacent Beam Interference Ebi/I0:		**14.2**	**14.2**	**14.2**	**dB**
TOTAL:					
TOTAL Ebi/(N0 + I0):		**4.5**	**4.5**	**4.5**	**dB**
Min. reqd. Ebi/N0 (1% frame error rate):	3.5				dB
Implementation Loss Margin		**1.0**	**1.0**	**1.0**	**dB**

Return Link Budget

Four Cell Frequency Reuse Cluster Size

INFORMATION RATE (for calculating Ebi):		
User data plus in-band signaling:	**4.8**	kbps
CHANNEL/SATELLITE LOADING:		
Simultaneous users per carrier:	24	
Total number of co-freq. beams:	71	
UPLINK Ebi/N0 (thermal):		
Terminal SSPA Output Power	-6.0	dBW
Diplexer/Feed Loss	-1.0	dB
Terminal Tx Antenna Gain	**1.0**	dBi
Reduction in Ebi due to pilot power:	-1.0	dB
Terminal Uplink EIRP:	**-7.0**	dBW
U/L Path Loss	-190.3	dB
Allocated fading and blockage loss	**-9.0**	dB
S/C G/T:	20.5	dB/K
2-Polarization recombination gain	**1.0**	dB
2-satellite diversity improvement	0.0	dB
Uplink Ebi/N0:	**7.0**	**dB**
DOWNLINK Ebi/N0 (thermal):		
Reston Hub E/S G/T	36.5	dB/K
Total S/C downlink EIRP	47.0	dBW
Total return downlink bandwidth	250.0	MHz
Bandwidth per CDMA channel	1.25	MHz
Num. simultaneous users per channel	24.0	
Satellite EIRP per user per return carrier:	**10.2**	**dBW**
Rain loss (w/ site diversity)	-6.0	dB
Path loss	-205.2	dB
2-satellite diversity improvement - D/L:	0	dB
Boltzmann's constant	-228.6	dBW/Hz.K
Downlink Ebi/N0:	**27.3**	**dB**

INTRA-BEAM SELF INTERFERENCE Ebi/I0:		
Num. Interfering Terminals in Beam	23	
Imperfect Power Control Factor	0.5	
Chip rate:	1228.8	kcps
Processing Gain:	256.0	
Ebi/I0 due to processing gain only:	**7.3**	**dB**
2-Polarization recombination gain	1.0	dB
2-satellite diversity improvement:	0.0	dB
Voice activity improvement factor:	2.0	dB
Self-Jamming Ebi/I0 (intra-beam):	**10.3**	**dB**
INTER-BEAM INTERFERENCE Ebi/I0		
Avg. S/C antenna discrimination to adj. beams:	**20.6**	dB
Total interbeam C/I	2.1	
Number of co-freq. interfering beams:	70	
Number of simultaneous users per beam:	24.0	
Processing Gain:	256.0	
Imperfect Power Control Factor	-3.0	dB
Ebi/I0 due to processing gain only:	**9.3**	**dB**
2-satellite diversity improvement:	0.0	dB
2-Polarization recombination gain	1.0	dB
Voice activity improvement factor:	2.0	dB
System loading	100%	
Aggregate Ebi/I0 fm. all adjacent beams:	**12.3**	**dB**
SUMMARY:		
U/L Ebi/N0 (thermal):	7.0	dB
Intra-beam Self-Jamming Ebi/I0:	10.3	dB
D/L Ebi/N0 (thermal):	27.3	dB
Adj. spot beam interference Ebi/I0	12.3	dB
TOTAL Ebi/(N0 + I0):	**4.5**	**dB**
Min. reqd. Ebi/N0 (1% frame error rate):	3.5	dB
Implementation Loss Margin	**1.0**	**dB**

Capacity Limits

Capacity Limit Based on Satellite Power:		
Average fading and blockage	5	dB
Satellite antenna gain:	48.0	dBi
Sat. SSPA total output power:	33.0	dBW
Satellite feed losses	-1.0	dB
Satellite aggregate EIRP	80.0	dBW
2-satellite operation:	0.0	dB
% sat. EIRP available for CDMA:	100.0%	
Total available satellite EIRP:	**80.0**	dBW
EIRP per forward carrier:	47.4	dBW
Total # forward cxrs. supported:	**1,801**	
Max. users per carrier:	24	
Total # simultaneous voice ccts.:	**43,224**	
Capacity Limit Based on Available Banwidth		
Available bandwidth	10	MHz
Frequency reuse factor	**4**	
No. of spot beams	**285**	
No. of frequency reuse clusters	71	
No. of frequency sets in each cluster	2	
No. of (distinct) frequencies in each cluster	8	
Occupied bandwidth	10	MHz
No. of carriers in total system	**568**	
Max. users per carrier:	24	
Total # simultaneous voice ccts.:	**13,632**	

Supplement E

Capacity of Satellite using 2 x 10 MHz of Spectrum to Serve First Responder's Vehicular-Mounted User Equipment with a Four Cell Frequency Reuse

- **Satellite AEIRP: 80 dBW**
- **Satellite G/T: 20.5 dB/°K**
- **Air Interface Protocol: cdma2000 1X**
- **Service: 16 kbps data**
- **First Responder's User Equipment: $EIRP_{MAX}$ = 0 dBW; G/T = -22 dB/°K; circularly-polarized antenna with gain of 5 dBi**

Forward Link Budget
Four Cell Frequency Reuse Cluster Size

		<== Channel-specific ==>			
CHANNEL PARAMETERS:	**Common Parameters**	**Sync. Channel**	**Paging Channel**	**Traffic Channel**	Units
Total number of chnls. per forward carrier:		1	3	10	
Channel info. rate (for calculating Ebi):		1200.0	4800.0	16000.0	bps
Transmit duty factor or voice activity fac.:		0.0	0.0	-1.0	dB
Forward carrier chip rate:	1.2288				Mcps
Pct. forward cxr. pwr. allocated to Pilot Ch.:	20.0%				
Total number of co-frequency spot beams:	71				
DOWNLINK Ebi/N0 (thermal):					
Satellite EIRP per channel:		32.0	38.0	**43.0**	dBW
Path loss:	-191.0				dB
Polarization mismatch loss (CP to LP):	0.0				dB
Fading and blockage allocation	**-6.0**				**dB**
User terminal G/T:	-22.0				dB/K
Boltzmann's constant:	-228.6				dBW/Hz.K
Downlink Ebi/N0:		**10.8**	**10.8**	**10.5**	**dB**
UPLINK Ebi/N0 (thermal):					
E/S EIRP to Satellite EIRP conversion:	5.0				dB
Earth station EIRP per channel:		37.0	43.0	48.0	dBW
Uplink path loss:	-206.7				dB
Uplink rain loss (assume site diversity):	-6.0				dB
Satellite G/T:	14.0				dB/K
Boltzmann's constant:	-228.6				dBW/Hz.K
Uplink Ebi/N0:		**36.1**	**36.1**	**35.9**	**dB**
INTRA-BEAM SELF INTERFERENCE (due to imperfect rejection of Walsh codes):					
Orthogonality impairment factor:	8.0				dB
Forward carrier EIRP (time-averaged):	53.1				dBW
CDMA processing gain:		30.1	24.1	18.9	dB
Self-Interference Ebi/I0 (multi-path):		**17.0**	**17.0**	**16.8**	**dB**
INTER-BEAM INTERFERENCE:					
Sat. antenna adjacent spot beam discrimination:	20.6				dB
Total number of interfering co-freq. carriers:	70				
Interfering carrier EIRP (time-avg.):	53.5				dBW
CDMA processing gain:		30.1	24.1	18.9	dB
System loading		99%	99%	99%	
Adjacent Beam Interference Ebi/I0:		**10.8**	**10.8**	**10.6**	**dB**
TOTAL:					
TOTAL Ebi/(N0 + I0):		**7.3**	**7.3**	**7.0**	**dB**
Min. reqd. Ebi/N0 (1% frame error rate):	6.5				dB
Implementation Loss Margin		**0.8**	**0.8**	**0.5**	**dB**

Return Link Budget
Four Cell Frequency Reuse Cluster Size

INFORMATION RATE (for calculating Ebi):		
User data plus in-band signaling:	**4.8**	kbps
CHANNEL/SATELLITE LOADING:		
Simultaneous users per carrier:	24	
Total number of co-freq. beams:	71	
UPLINK Ebi/N0 (thermal):		
Terminal SSPA Output Power	-3.0	dBW
Diplexer/Feed Loss	-1.0	dB
Terminal Tx Antenna Gain	**5.0**	dBi
Reduction in Ebi due to pilot power:	-1.0	dB
Terminal Uplink EIRP:	**0.0**	dBW
U/L Path Loss	-190.3	dB
Allocated fading and blockage loss	**-9.0**	dB
S/C G/T:	20.5	dB/K
2-Polarization recombination gain	**1.0**	dB
2-satellite diversity improvement	0.0	dB
Uplink Ebi/N0:	**14.0**	**dB**
DOWNLINK Ebi/N0 (thermal):		
Reston Hub E/S G/T	36.5	dB/K
Total S/C downlink EIRP	47.0	dBW
Total return downlink bandwidth	250.0	MHz
Bandwidth per CDMA channel	1.25	MHz
Num. simultaneous users per channel	24.0	
Satellite EIRP per user per return carrier:	**10.2**	**dBW**
Rain loss (w/ site diversity)	-6.0	dB
Path loss	-205.2	dB
2-satellite diversity improvement - D/L:	0	dB
Boltzmann's constant	-228.6	dBW/Hz.K
Downlink Ebi/N0:	**27.3**	**dB**

INTRA-BEAM SELF INTERFERENCE Ebi/I0:		
Num. Interfering Terminals in Beam	23	
Imperfect Power Control Factor	0.5	
Chip rate:	1228.8	kcps
Processing Gain:	256.0	
Ebi/I0 due to processing gain only:	**7.3**	**dB**
2-Polarization recombination gain	1.0	dB
2-satellite diversity improvement:	0.0	dB
Voice activity improvement factor:	2.0	dB
Self-Jamming Ebi/I0 (intra-beam):	**10.3**	**dB**
INTER-BEAM INTERFERENCE Ebi/I0		
Avg. S/C antenna discrimination to adj. beams:	**20.6**	dB
Total interbeam C/I	2.1	
Number of co-freq. interfering beams:	70	
Number of simultaneous users per beam:	24.0	
Processing Gain:	256.0	
Imperfect Power Control Factor	-3.0	dB
Ebi/I0 due to processing gain only:	**9.3**	**dB**
2-satellite diversity improvement:	0.0	dB
2-Polarization recombination gain	1.0	dB
Voice activity improvement factor:	2.0	dB
System loading	99%	
Aggregate Ebi/I0 fm. all adjacent beams:	**12.4**	**dB**
SUMMARY:		
U/L Ebi/N0 (thermal):	14.0	dB
Intra-beam Self-Jamming Ebi/I0:	10.3	dB
D/L Ebi/N0 (thermal):	27.3	dB
Adj. spot beam interference Ebi/I0	12.4	dB
TOTAL Ebi/(N0 + I0):	**7.2**	**dB**
Min. reqd. Ebi/N0 (1% frame error rate):	6.5	dB
Implementation Loss Margin	**0.7**	**dB**

Capacity Limits

Capacity Limit Based on Satellite Power:		
Average fading and blockage	5	dB
Satellite antenna gain:	48.0	dBi
Sat. SSPA total output power:	33.0	dBW
Satellite feed losses	-1.0	dB
Satellite aggregate EIRP	80.0	dBW
2-satellite operation:	0.0	dB
% sat. EIRP available for CDMA:	100.0%	
Total available satellite EIRP:	**80.0**	dBW
EIRP per forward carrier:	52.5	dBW
Total # forward cxrs. supported:	**562**	
Max. users per carrier:	10	
Total No. of Users	**5,620**	
Capacity Limit Based on Available Banwidth		
Available bandwidth	10	MHz
Frequency Reuse Cluster Size	**4**	
No. of spot beams	**285**	
No. of frequency reuse clusters	71	
No. of cdma2000 carriers per cell	2	
No of cdma2000 in each cluster	8	
Occupied bandwidth	10	MHz
No. of carriers in total system	**568**	
Max. users per carrier:	10	
Total No. of Users	**5,680**	

TECHNICAL CERTIFICATION

I, Michael T Lyons, a consultant to TerreStar Networks Inc., certify under penalty of perjury that:

I am the technically-qualified person with overall responsibility for the technical information contained in this filing.

I hold a Bachelor of Chemical Engineering degree from Catholic University and a Masters in Industrial Administration from Carnegie Institute of Technology. I am founder of Lyons Aerospace which provides consulting services to the communications satellite industry. Prior to this position, I was Vice President and General Manager of the Space Resources Division of Satellite Business Systems (SBS), where I was responsible for the specification, procurement, launch and operation of five SBS FSS communication satellites. I continued with those responsibilities after SBS was acquired by MCI, where I was Vice President for Space Resources. I subsequently joined NASA Headquarters as Deputy Associate Administrator for Flight Systems. Following retirement from NASA, I was retained by MCI as a consultant and served as Program Manager for the development of two BSS satellites, which were launched as EchoStar 5 and 6. I have served as a consultant to many communications satellite ventures.

To the best of my belief, the technical information contained in the present filing is true and correct.

Michael T Lyons
Lyons Aerospace

July 29, 2005

Technical Appendix - Exhibit 1

Letter from Hughes Network Systems

HUGHES
NETWORK SYSTEMS

April 15, 2005

Dr. Peter D. Karabinis
Vice President & CTO
MOBILE SATELLITE VENTURES, LP.

Subject: ATC Terminal Assessment

Dear Peter:

At your request, HNS has conducted a preliminary assessment of the estimated hardware impact to add satellite functionality to a cellular phone in support of Ancillary Terrestrial Component (ATC) operation. I am please to provide our current opinion on this subject based upon our mobile satellite terminal knowledge and a brief study given the assumptions that you have furnished us with.

As you know, HNS has successfully developed and deployed the satellite/GSM/GPS phone for the UAE based operator Thuraya, the first commercially successful satellite/cellular hybrid service in the world. While not an ATC phone *per se*, the Thuraya terminal incorporates many of the tenants anticipated for such a product. The Thuraya phone has a GSM protocol stack that is tightly coupled to both terrestrial and satellite operation. Likewise, significant baseband and radio circuit reuse was achieved in the implementation of both modes. More specifically, commercially available GSM cellular technology was utilized to satisfy both the terrestrial and satellite requirements in the design. The resulting product delivers to the end user a consistent and homogeneous service experience in a compact and light weight handset and equally importantly, a economically viable service offering.

The ATC terminal assumptions that you have supplied to us are central to the conclusions of this preliminary assessment. These assumptions include an ATC terminal production volume of at least five million units per year along with the full cooperation of both a mainstream cellular chipset vendor and a large volume cellular phone manufacturer to fully capitalize on their technology investment and manufacturing efficiencies. Furthermore, the satellite and ground system capabilities, e.g. beam forming and interference cancellation, are assumed to be sufficient to close the link with 10dB of fade margin using a handset with a -6dBW power amplifier and -4 dBi average linear antenna gain.

Given the above assumptions, we concur that the primary additional bill of material elements to support satellite operation can be constrained to a T/R switch or duplexor, an LNA, three inter-stage filters, a PA and between 250,000 to 750,000 of new gates in the existing terrestrial baseband chip. While HNS has not produced phones in the quantity that is given in the assumptions, our knowledge of high volume cellular phone costs leads us to believe that a $5 bill of material cost delta is reasonable for the components listed above. Furthermore, our design experience confirms that a noise figure of 2.5dB or lower can be achieved by the receiver using a T/R switch. Should full duplex operation be required, our initial assessment is that a noise figure of 3.1dB for a ceramic duplexor and 5.2dB for a

9605 Scranton Road, Suite 500, San Diego, CA 92121
Tel: (858) 452-4706 FAX: (858) 452-4624

SAW duplexor can be achieved. It may be possible to further improve upon these figures, but additional duplexor technology investigation is required.

With respect to the physical dimensions of the ATC phone, the utilization of a half duplex T/R switch design would have minimal impact on the industrial design of a typical cellular phone. The addition of a SAW duplexor design would add a small amount of volume, similar to that experienced by multi-band CDMA phones. The addition of a ceramic duplexor design would add somewhat more volume due to the physical nature of that type of device. The packaging of the antenna is also a critical element of the ATC handset. To avoid head and hand effects, the utilization of a small, extendable mono-pole whip antenna is advisable. This antenna would be similar in size and construction to those found on many models of North American cellular phones today.

This letter is intended to provide preliminary guidance only as additional analysis, with supporting information from your satellite vendor, would be needed to rigourously qualify our assessments. HNS certainly appreciates the opportunity to work with MSV on the ATC program and we look forward to supporting the development of your next generation hybrid satellite and cellular system in the US.

Best regards,

Graham Avis
Vice President
Hughes Network Systems

9605 Scranton Road, Suite 500, San Diego, CA 92121
Tel: (858) 452-4706 FAX: (858) 452-4624

Technical Appendix - Exhibit 2

Letter from Nils Rydbeck, Rydbeck Consulting

Rydbeck Consulting July 28, 2005

To: TerreStar Management:

It is my opinion that satellite functionality can be incorporated into modern communications devices with only a small impact in manufacturing cost and form factor, provided the space segment is sufficiently powerful to close the link with the device's antenna being small (i.e., built in antenna) and the air interface in satellite mode is a close derivative of a terrestrial air interface. Sufficient link margin (10 dB or more) should be allocated for fading and blockage for reasonable quality of voice and data services in a mobile satellite link environment. The low cost impact stated above assumes that all the digital functions of the communications device are executed in the same (modified) hardware microcircuits that are used for the terrestrial air interface and that the satellite mode protocol stack is executed in the same processor as that used for the terrestrial service. For a modern cellular/PCS communications device, following the above design approach, the manufacturing cost increase to incorporate MSS functionality should be containable within $5 if the microcircuit vendor is cooperating.

As the ex-CTO of Ericsson's mobile phone business, I have done this before, for the ACeS and Globalstar systems, and I know what mistakes not to repeat so that the cost may be contained and the product is attractive. These include:

- Ensure that the space segment has a very large antenna.
- Ensure that the air interface is very close to a terrestrial standard.
- Ensure that the microchips are reusing as many modules as possible for satellite functions with minimum modification.
- Ensure that the phones are as attractive to the end user as other cellular phones.

Regards,

Nils Rydbeck, Professor, Consultant

943 Flagship Drive
Summerland key, FL 33042 USA

Technical Appendix - Exhibit 3

Letter from Space Systems/Loral

TS1-06
July 28, 2005

Mr. Zie Rivers
CEO
TerreStar Networks, Inc
7925 Jones Bridge Rd.
McLean, Virginia 22102

Subject: Impact of TerreStar-1 Transmit Power reduction

Dear Zie:

The following information is provided in response to your question regarding the impact of reducing the TerreStar transmit power (AEIRP) by 2 dB relative to the current design.

1. The transmit power reduction on TerreStar-1 amounts to a reduction of payload power requirement by 1350 watts. This is approximately 9% of the current Solar Array power capability. This reduction can be achieved by changing the solar cells on one panel in each wing from Advance Triple Junction (ATJ) Gallium Arsenide cells to Advanced High Efficiency Silicon (AHES) cells. There would be no other impact to the satellite design.

2. The power rating of the Traveling Wave Tube Amplifiers (TWTA) can be reduced from 100 watts to 65 watts; however, the price of the TWTAs are not affected by this reduction in rating.

The net reduction to the satellite price would therefore be approximately 0.3% of the current price.

If you need additional information please do not hesitate to contact me.

Sincerely,

(K.P. Bhat)
Executive Director,
TerreStar Program

Comments of TMI and TerreStar
WT Docket No. 05-221

EXHIBIT B: Declaration of Peter Cowhey

Declaration of Peter Cowhey

My name is Peter Cowhey. I am the Dean of the Graduate School of International Relations and Pacific Studies at the University of California, San Diego. I am also the Qualcomm Professor of Communications and Technology Policy. I have published numerous books and papers on the global communications industry and policy, including studies of the wireless and satellite markets. In addition, I have served as the Senior Counselor for International Economic and Competition Policy at the FCC and as the Chief of the International Bureau of the FCC. I have also advised numerous companies in the communications industry, including wireless and satellite technology firms.

TMI/TerreStar has asked me to offer my expert opinion on two closely related questions:
1. Would the TMI/TerreStar system enhance consumer welfare in its target market?
2. What are the minimum economies of scale necessary for a satellite system like TMI/TerreStar to succeed? In particular, what economies of scale are necessary in the provision of terminal equipment in order to have a competitive offering? What do these economies of scale imply about system capacity and spectrum?

I have examined the proprietary information of TMI/TerreStar in regard to its business plan and vendor relationships. I have compared this information to my own analysis of the dynamics of the industry in order to assess the claims of TMI/TerreStar. This declaration states my expert conclusions.

I. Consumer Benefits and Competition Issue

TMI/TerreStar proposes to launch a 2GHz (S Band) Satellite system featuring a satellite with very substantial capacity that allows it to serve terrestrial terminals effectively. These satellites will be integrated with an ancillary terrestrial component (ATC) in a manner that will conform to the FCC requirements stipulated in its February 25 Order.[1] The result will be a hybrid system that can serve both urban and rural areas on a seamless basis with voice and broadband data services utilizing a single terminal.

A. Benefits for Consumers

The target markets where the system will offer particular benefit, in my opinion, especially in three segments: 1. emergency and public services requiring ubiquity, high quality and reliability of service standards (including survivability in adverse conditions), and security measures; 2. vertical market segments of business applications featuring both urban and rural coverage, such as electric utilities and trucking systems that require quality of assurance, reliability and security guarantees; and, 3. rural consumers in both the residential and business markets who lack robust competition in phone services and have few alternatives for data services better than 56 K dial-up modems.

[1] FCC, Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L Band and the 1.6/2.4 GHz Band, IB Docket No. 01-185, FCC 05-30 (released Feb. 25, 2005)

From the viewpoint of analyzing the gain for consumer welfare from TMI/TerreStar the key is its national rural coverage with a combination of voice and data rates that easily exceed conventional cellular systems while providing high levels of security, reliability, and quality. (Second generation wireless systems (2G), for example, provide data rates that are significantly less than even 56K landline modems.[2]) This combination of features is what is particularly attractive in the first and second market segments because advanced wireless networks for these market segments are likely to remain clustered around urban centers and the largest highway corridors for the next several years. And for residential and SME customers who are purely in the rural market there are, in many cases, no ready alternatives for this kind of integrated voice and data service (including higher data rates than conventional dial-up services).[3]

B. Competition Analysis

The Commission has created a rebuttable presumption that there should be more than two MSS providers in the 2GHz band. The purpose of the presumption is that it will enhance consumer welfare by providing more competition. However, the TMI/TerreStar petition shows why the Commission's presumption does not serve its goal of enhancing consumer welfare by assuring more MSS competitors in this band. In fact, this approach clashes with the Commission's own rethinking of spectrum policy. An approach more consistent with general Commission policy on spectrum would release large enough blocks of spectrum for MSS systems in the 2GHz band to allow market driven choices about technology and service mixes.

While it is perfectly appropriate for the Commission to be worried that spectrum allocations and assignments might in some cases lead to limited numbers of competitors in a market, this is not the risk here. Permitting two 2 GHz MSS providers to share the current allocation will not limit MSS to two competitors. To consumers, the spectrum band in which an MSS provider operates is irrelevant. Other MSS licensees in the L-band, 1.6/2.4 GHz ("Big LEO"), and Little LEO bands, such as Inmarsat, Globalstar, and

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[2] A representative estimate of 2G speeds is 10-30 kbps. 2.5G systems are considerably faster but also not extensively deployed outside the major market centers. 3G systems are more distance sensitive in their signals. Morgan Stanley, Telecommunications Services and Equipment: Cross-Industry Insights, Feb. 2005..

[3] The Commission has been modifying its spectrum policies so as to make new terrestrial wireless systems, such as higher powered versions of 802.11 systems, more easily deployed in rural areas. These services do provide data rates higher than conventional cellular and dial-up landline services. They can also support VoIP in theory. However, these services on unlicensed bands do not offer guarantees of quality, reliability, and security comparable to those made possible by the TMI/TerreStar system. An alternative service with these guarantees, attractively priced and with substantial data speed, would be a substantial addition to consumer choice in rural areas.

ORBCOMM, would provide competition to the two 2 GHz MSS providers.[4] The 2 GHz MSS providers also face competition from Fixed Satellite Service operators that provide land,[5] aeronautical,[6] and maritime[7] MSS. Also, given the recent surrenders, it no longer seems defensible for the FCC to make an *a priori* judgment about the number of 2 GHz MSS competitors that the market will actually support or the spectrum that they will need. The 2 GHz MSS is in its infancy with satellite launch milestone still 2 years away. For all of these reasons, an inflexible assumption about the number of 2 GHz MSS competitors necessary to make reasonably efficient use of surrendered spectrum is no longer legally or factually supportable

Second, it would be a mistake to define the consumer end market by the supply technology. The effective consumer welfare question is how to increase competition and service options for certain consumer segments that currently have limited supply options. In short, the Commission should look at competition policy analysis as its primary tool and not rely on a mechanical use of limits on spectrum holdings.[8] The question really before the Commission is whether or not to increase the effective number of competitors for the provision of integrated voice and high speed data services to market segments (defined in I.A of this declaration) with few existing choices. Creating new competitive supply options in the 2GHz MSS market will increase effective competition in these end market segments. This is especially true because new entrants like TMI/TerreStar have every incentive to offer innovative service and price packages in order to compete against incumbents who have well developed brands.

II. Economies of Scale and System Capacity

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4 Each of these systems has its own particular mix of technical capabilities and market strategies. They will compete against TMI/TerreStar's market offerings according to these capabilities and strategies.

5 *See Qualcomm, Inc., Memorandum Opinion, Order and Authorization*, 4 FCC Rcd 1543 (1989) (authorizing land mobile MSS on a secondary basis in the Ku-band).

6 *Service Rules and Procedures to Govern the Use of Aeronautical Mobile Satellite Service Earth Stations in Frequency Bands Allocated to the Fixed Satellite Service, Notice of Proposed Rulemaking*, FCC 05-14 (February 9, 2005) (proposing rules for operation of aircraft earth stations in the Ku-band); *Boeing Company, Order and Authorization*, 16 FCC Rcd 22645 (Int'l Bur. & OET, 2001) (permitting operation of two-way mobile terminals aboard aircraft in the Ku-band).

7 *See Procedures to Govern the Use of Satellite Earth Stations on Board Vessels in the 5925-6425 MHz/3700-4200 MHz Bands and 14.0-14.5 GHz/ 11.7-12.2 GHz Bands, Report and Order*, FCC 04-286 (January 6, 2005) (establishing licensing and service rules for Earth Stations on Vessels ('ESVs') in the C-band and Ku-band).

8 Bruce Owen. and Gregory L. Rosston "Spectrum Allocation and the Internet," Stanford Institute for Economic Policy Research Discussion Paper No. 01-09, December 2001. Published in Cyber Policy and Economics in an Internet Age, W. Lehr and L. Pupillo, (eds.) , Kluwer Academic Publishers, New York, 2002.

The ability of the TMI/TerreStar system to provide consumer benefits depends crucially on its success in creating a handset/terminal device that provides for a seamless satellite/terrestrial experience wherever the customer goes. To be viable it must match the cost, battery life, and form (e.g., weight, size, and screen) factors of handsets/terminals for terrestrial only systems. Otherwise, TMI/TerreStar will face the same market difficulties that plagued earlier, failed MSS systems. For emergency/public services and vertical business segments TMI/TerreStar must be a viable alternative for the convenience, price and ease of use of terrestrial systems.

A competitive handset/terminal means that TMI/TerreStar has to achieve the economies of the mass consumer electronic industry. Mobile handsets constitute the largest single market. In 2004 there were 650 million handsets shipped in the industry and a handful of vendors dominate.[9] This has generated very large scale economies. For example, despite being a relatively new and sophisticated product that requires substantial new tooling and engineering work, 3G phones are shipping for around $300-500 per phone, according to Morgan Stanley.[10] Moreover, both of the currently dominant versions of 3G—cdma 1X/EVDO and UMTS—now have multiple vendors rapidly turning out a stream of new product offerings.[11] A multi-vendor supply chain provides a more competitive array of innovative features and cost performance improvements at a faster pace. This is particularly important because the overall market for handsets is moving to higher end smart phones.[12]

The TMI/TerreStar handset/terminal will require significant engineering work. These requirements in themselves, as a rule of thumb in the industry, necessitate a minimum production run of substantially over one million units per year. Keeping costs down to be competitive with handsets for large terrestrial systems requires even larger minimum volumes.[13] Therefore, TMI/TerreStar estimates that a vendor will require a potential

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9 In-Stat estimated the market to be about 670 million handsets in 2004. In-Stat, Handset Market Thunders, But Leaner Growth Ahead: Q4, 2004. March 2005. The market leader, Nokia, typically has roughly 30% of the world market. The top five vendors are typically Nokia, Motorola, Samsung, Sony Ericsson, and Siemens although LG, Kyocera and Sanyo are larger players in the CDMA market. Thus, there are huge scale economies in these producers. Even a company not in the top five vendors, such as Sharp, expects to produce 10 million units in a year. "Sharp targets 10% growth in cellular handsets," http://smh.com.au,articles/2004/07/09/10890000324924.html.

10 Morgan Stanley, Telecom Services and Equipment: Cross-Industry Insights, February 2005. These prices include some level of carrier subsidy.

11 Morgan Stanley, Telecom Services and Equipment.

12 One forecast is that mid range feature to high end smart phones will constitute 85% of new unit sales by 2009. ARC, Future Mobile Handsets, Worldwide Market Analysis and Strategic Outlook, 2004.

13 The average sales price of the 119 million mobile handsets sold in the US in 2005 was $145. While TMI/TerreStar is competing at a more sophisticated level of features than the average handset provides, this price suggests the competitive discipline of the

market of approximately 1.5 to 2 million units per year in order to supply new equipment.[14] This number seems entirely reasonable given the sophistication of the new product and the necessity of keeping costs comparable to conventional terrestrial terminals.

A scale of 1.5 to 2 million units for a vendor has further implications for the necessary size of a competitive TMI/TerreStar system.[15] A competitive offering requires constant, quick innovation in product offerings and improvement in cost structures as margins also grow narrower over time. Thus, to maintain a competitive supply base for handsets, TerreStar needs a market capable of supporting three vendors (or an ultimate volume of about 4.5 to 6 million units per year). However, it takes a larger customer base (and, hence, system capacity) to support this annual volume of sales.

The calculation of the necessary customer base to create the volume of handset production required for economies of scale is sensitive to the churn rate for customers (the percentage of customers leaving TMI/TerreStar in a year), rates at which handsets/terminals are replaced by new models, and the degree to which other competitors for integrated satellite-terrestrial systems have similar equipment orders. Using a variety of assumptions TMI/TerreStar has concluded that maintaining a sales volume for three vendors at the minimum scale over a multi-year period implies the need for a system capable of supporting a total of fifteen to twenty five million customers.[16] I have examined the TMI/TerreStar calculations and find them to be reasonable.

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market. Ed Wallace, US Mobile Markets: Analysis and Forecasts, The Diffusion Group, February 2005.

14 This range might incorporate several different models from a vendor. There are joint costs for engineering, for example, that can be spread across the models.

15 In my judgment it is not feasible to be overly precise about the total scale economies because assumptions about pricing drive the margins of the equipment vendors and thus the precise volume of production needed.

16 For example, this total is sensitive to how much volume for handset/terminals is generated by a competitor to TMI/TerreStar in the 2 GHz band. The calculation of the necessary base is also sensitive to the churn rate. TMI/TerreStar has used a base line estimate of a 20% churn rate, which is somewhat higher than that of Nextel (another specialized product offering) but lower than the industry norm. A common number used for major European carriers, for example, is 22%. (The more mature European mobile wireless market is a relevant benchmark for where the United States will be in the next two or three years.) A higher churn rate reduces the total size of the necessary customer base because there would be a higher level of handset/terminal replacement each year. Therefore, the choice of a twenty percent churn rate means that TMI/TerreStar has not used a churn rate that inflates the estimates of system capacity upward. The lowest churn rate of which I am aware is that of Teliasonera in Sweden at 12%. Analysis Research, Retaining Customers and Minimising Churn, 2004. The European average is much higher. The 22% figure is from: Michelle de Lussanet, "Boosting Mobile Customer Loyalty," Forrester Research, March 2005.

TMI/TerreStar has argued that the spectrum necessary to support this customer capacity and the service features required in the growing market for sophisticated mixes of data and voice is at least 2 x 10 MHz. I cannot offer an expert opinion on this engineering calculation concerning spectrum. However, as a practical matter, licensed mobile carriers are finding the economics of the new broadband systems supporting voice and data require larger spectrum capacity in order to support flexible mixes of services with high levels of quality and reliability. A recent survey of major European markets showed that the smallest amount of spectrum per carrier for 3G is 20 MHz and some countries are allocating up to 40 MHz[17]. All studies with which I am familiar expect a significantly rising share for data on the wireless systems of the future. Even with more spectrum efficient technologies this implies that major competitors will have to seek more bandwidth to stay competitive. This is arguably an important benefit from some of the proposed mergers of wireless carriers now pending before the Commission. The smallest spectrum holding of any major U.S. or Canadian wireless carrier is 20 MHz, and all others are, or prospectively will be, substantially larger.[18] Thus, if the purpose of the Commission is to generate more consumer choices, especially in markets involving rural customers, it would make sense to assign more spectrum for each entrant if it is possible. In the case of the 2GHz MSS systems, the option of more spectrum for each entrant is available.

III. Summary

The potential for a satellite system like TMI/TerreStar depends on delivering a seamless satellite-terrestrial network with a handset/terminal that is comparable to those of a pure terrestrial network. This will require major economies of scale. In turn, a large system capacity is necessary to service the minimum customer base that can generate the necessary demand for handsets. It is reasonable to size this customer capacity at 15 to 25 million users.

If TMI/TerreStar succeeds, it can provide significant consumer welfare benefits to key markets where there are few competitive supply options. This is particularly true in rural markets and markets that need to cover an integrated rural-urban base (such as emergency services). The benefit is particularly attractive because TMI/TerreStar (and comparable satellite/terrestrial systems) can provide integrated voice and high speed data services with key features involving quality of service, reliability and security. As is the case with all major mobile wireless services today, increased spectrum holdings to allow sustained high performance for a greater variety of applications have emerged as a major feature of the market place. TMI/TerreStar's request for a minimum of 2x10 MHz is completely consistent with the spectrum holdings deemed essential by all of its major competitors. This grant of spectrum would enhance, not reduce, competition in the relevant end markets.

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17 Morgan Stanley.

18 The next smallest would be the combined Sprint PCS-Nextel holding of 47 MHz. Morgan Stanley, p. 4.

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Date: April 19, 2005

Comments of TMI and TerreStar
WT Docket No. 05-221

EXHIBIT C: Supplemental Declaration of
Peter Cowhey

Supplemental Declaration of Peter Cowhey

At issue in this proceeding is whether the remaining available 2 x 6.67 MHz of available S-band spectrum should be subject to redistribution, reassignment or reallocation and to the competitive implications of having two operators in the S band (as opposed to three).[1] The answers to these questions go to the heart of FCC licensing policy for satellites.

Although the terrestrial wireless industry has long objected to it, Congress has legislated that spectrum policy for satellites must be different than for terrestrial services. In particular, Congress removed the option of auctions for spectrum for satellite systems used for providing international communications. The FCC spectrum allocation and assignment system for satellites, and the understanding of how satellite systems can promote the public interest goals set forward by the Commission, has to evolve within the premise that Congress has instructed the FCC to use its best judgment to determine how to best manage the allocation and assignment of spectrum for satellites.[2]

The question before the Commission is how new satellite systems can best serve the Commission's public interest goals of serving three user communities:[3]

1. supporting emergency service providers and national security
2. advancing the delivery of broadband services to rural consumers; and,
3. advancing general consumer welfare by promoting competition and innovation in the delivery of wireless services.

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[1] *See Commission Invites Comments Concerning Use of Portions of Returned 2 GHz Mobile Satellite Service Frequencies*, Public Notice, FCC 05-134, IB Docket No. 05-221 (rel. June 29, 2005) (requesting comments concerning use of 2 x 6.67 MHz of recaptured 2 GHz MSS spectrum).

See Open-Market Reorganization for the Betterment of International Telecommunications Act, Pub. L. No. 106-180, 114 Stat. 48 § 647 (enacted March 12, 2000), codified at 47 U.S.C. § 765f ("ORBIT Act"); 2000 Biennial Regulatory Review – Streamlining and Other Revisions of Part 25 of the Commission's Rules Governing the Licensing of, and Spectrum Usage by, Satellite Network Earth Stations and Space Stations, 17 FCC Rcd. 18585, 18591 ¶ 10 (2002) (explaining relationship between promotion of satellite service and efficient spectrum management); *See* FCC Report to Congress on Spectrum Auctions, FCC 97-353, WT Docket 97-150 (rel. Oct. 9, 1997) ("A variety of mechanisms can be used to distribute such scarce resources among users. Historically, the FCC has used auction, lotteries, and assignment by comparative hearing to award licenses for the use of radio spectrum.").Unlicensed spectrum, an approach that is not relevant in this case, is an important variation on administrative deliberation.

[3] *See, e.g.*, 19 FCC Rcd. 16830, 16836 (2004) (discussing the immediate aftermath of the terrorist attacks of Sept. 11, 2001, and noting that "satellite communications … were used to initiate the movement of equipment and personnel into the affected areas for restoration purposes and to coordinate their work."); *Making the Rural Connection – FCC Rural Satellite Forum Final Details Announced*, FCC News Release (rel. Jan. 24, 2004); *Amendment of Parts 2 and 25 of the Commission's Rules to Permit Operation of NGSO FSS Systems Co-Frequency with GSO and Terrestrial Systems in the Ku-Band Frequency Range*, 16 FCC Rcd. 4096, 4099 (2000) (taking actions to "provide for the introduction of new advanced services to the public, consistent with our obligations under section 706 of the 1996 Telecommunications Act, and promote increased competition among satellite and terrestrial services.").

I urge the Commission to follow the logical conclusion of the path charted by its recent decisions on authorizing an ATC for satellite systems. There the Commission recognized that changes in technology and the marketplace meant that a satellite system integrated with an ancillary terrestrial network could deliver public interest benefits and efficiencies that a satellite system alone could not. The Commission recognized that the relevant public interest test was how satellite systems could best advance the end goals, and it introduced flexibility in the heretofore rigid distinctions between satellite and terrestrial suppliers. The FCC specifically stated in the ATC Order, that "we find that authorizing ATC will provide MSS operators with the possibility of achieving greater efficiencies within MSS spectrum than possible today by stand-alone MSS space stations or divided control of the MSS space and ground segments."[4]

Today, the further evolution of technology and the end markets of interest to public interest goals means that the Commission should take the next logical step in spectrum allocation and assignment—the awarding of the returned spectrum to TMI and ICO. There are two reasons for making this decision.

First, in terms of the three communities of end users, the goal should be to increase the number of effective options for providing services that encompass broadband data and voice service in a seamless manner. The FCC has already noted its concerns about adequate delivery of services to these three user communities.[5] TMI/TerreStar is designing a system that is explicitly designed to meet these needs. With adequate spectrum the existing 2 GHz licensees can also erase the artificial distinction between terrestrial and satellite mobile services that the Commission has observed in considering relevant markets.[6] Pricing and service features would be comparable to terrestrial for the purposes of competition and market size, and MSS providers would compete directly with terrestrial services.[7] In short, Commission policy can alter the definition of the

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[4] *Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Bands*, 18 FCC Rcd 1962 ¶ 20 (2003).

[5] *See, e.g., The Development of Operational, Technical, and Spectrum Requirements for Meeting Federal State and Local Public Safety Agency Communication Requirements through the Year 2010*, Fifth Memorandum Opinion and Order, __ FCC Rcd __ (2005) (considering recommendations); *Wireless Operations in the 3650-3700 MHz Band*, Report and Order and Memorandum Opinion and Order, ET Docket No. 04-151, FCC 05-56, at ¶ 1 (rel. March 16, 2005).

[6] *See, e.g., Applications of Western Wireless Corp. and ALLTEL Corp.*, Memorandum Opinion and Order, FCC 05-138, WT Docket No. 05-50, at ¶ 38 (rel. July 19, 2005) ("Western Wireless-ALLTEL Order") ("Generally, we limit our analysis to Cellular, PCS, and SMR facilities based carriers and exclude satellite carriers, wireless VOIP providers, MVNOs, and resellers consideration when computing initial measures of market concentration.").

[7] The potential for achieving this convergence of markets depends importantly on handset economics, as explained in my prior Declaration. In subsequent filings at the Commission other parties have objected to the point in my Declaration that notes the merits of having multiple suppliers in a fast changing environment that is extremely cost conscious. The rebuttal notes that Nextel successfully relied on a single supplier. This objection fails on two counts. On one hand, it is precisely the point of faster innovation and even stronger cost constraints that a single supplier strategy is less desirable. (On the pressures driving even many traditional suppliers of handsets to also outsource production and design to multiple firms in order to control costs and speed innovation, see: Robert Clark, "The big handset crackup," Wireless Asia,

relevant markets because its choices change the price and service features of the satellite services.[8]

Because FCC policy can change the features of the end services provided by satellite systems the Commission needs to take clear-eyed view of the argument about the number of operators in this band. The contention that the Commission should maintain a third competitor in the band makes two conceptual mistakes: confusing inputs with outputs and ignoring the endogeneity issue for market analysis. There is no particular reason why the Commission should care which technology delivers a service—it has deemed cellular, PCS and SMR supplied services to be interchangeable as an end market.[9] It has repeatedly embraced spectrum policy principles endorsing technology neutrality.[10] The right initial question for the Commission is whether or not the end market for the service is truly non-substitutable because a particular technology yields an output service that cannot be matched by another technology. In this case satellite ATC systems with sufficient spectrum yield a service that is interchangeable with terrestrial services. Thus, there is no reason for the Commission to be lost in the weeds of trying to create a separate satellite market of smaller potential size and benefit to end users, let alone a separate 2 GHz mobile satellite market.[11] It can make the more general market for mobile wireless services more innovative and generally available to users.

July/August 2004, Vol. 7, Issue 6.) On the other hand, if you rely on a single supplier, the laws of economics do not disappear. To justify that supplier's special attention to your needs (through large engineering teams and other commitments) the network service provider has to provide both economies of scale and margins to the supplier. Thus, TMI/TerreStar would still have to guarantee large scale economies, and arguably higher margins (due to sole sourcing), to the sole provider. It should also be noted that TMI/TerreStar's willingness to subsidize consumer purchasing prices has nothing to do with the economic necessity of managing its cost structure (so as to reduce losses on subsidies for handsets).

[8] It should be noted that the addressable end market would have the volume of the terrestrial market. TMI/TerreStar has argued that it needs a large market of end users to justify competitive handset economics. My accompanying Declaration explains why in my judgment their calculations are reasonable. There is no attempt to forecast the market demand for the service because winning customers is the business risk of TMI/Terrestar. The point is that the market for seamless voice and DSL-like data services is already large and growing, and by providing supply options to under-served segments (e.g., specialized users like emergency services and rural populations) it can be expanded. Given the characteristics of this market TMI/TerreStar and competitive capital markets are willing to take a risk on the proposition that enough customers can be won in the marketplace. The policy judgment for the Commission is not whether TMI/TerreStar will succeed as an individual competitor, but which choice about allocation and assignment of spectrum for satellite systems allows satellites to advance the public interest goals of the Commission.

[9] Western Wireless-ALLTEL Order at ¶ 38 ("We conclude that all the facilities-based Cellular, PCS, and SMR carriers that provide service in a geographic area are the relevant market participants for purposes of analyzing the mobile telephony service market for that area.").

[10] *See, e.g.*, Public Notice, *Public Invited to Review Draft Strategic Plan* (rel. July 5, 2005) ("Strategic Plan") ("The Commission shall define broadband in a technologically neutral fashion that includes any platform capable of transmitting high-bandwidth intensive services, applications, and content").

[11] *See* Jose del Rosario, *Inmarsat Pressured by Need to Shift Traditional* Focus, Satellite News (Nov. 1, 2004) (explaining marketplace shift in provision of MSS to provision of land-based services); *Global Fixed Satellite Services* Overview, Deutsche Bank, at 19 (July 2004) (noting that MSS providers have typically served businesses not reachable by terrestrial networks, such as the operators in the aeronautical and maritime sectors). These examples make clear the need for a viable hybrid satellite/terrestrial service to provide effective competition to other wireless telecommunications providers.

Second, technology changes in wireless services are moving faster and this has deep implications for satellite systems with up to fifteen year or even longer life spans in space. The rate of innovation in wireless technology is extremely high. As the Commission's own reports note, flexibility in spectrum and technology is highly desirable because of rapid innovation.[12] Major suppliers of wireless technologies have trumpeted a number of likely changes in speed and service features.[13] At the same time, the total number of users is growing. As a result, all major terrestrial competitors in mobile wireless services have announced plans to integrate various specialized new technologies into their main platforms (*e.g.*, WiMax) and they have built significant spectrum holdings, a minimum of 20 MHz for each of the major national players, in order to make reliable network deployment of flexible technologies to large numbers of users feasible.[14]

Space-based systems have a fifteen or more year lifespan in orbit. Hardware upgrades are impossible. However, software upgrades and flexibility in service packages made easier by having significant spectrum can make satellite systems responsive to the market on an on-going basis. More spectrum means that the satellite systems can offer higher average speeds for data and work with evolving complementary terrestrial technologies in a flexible manner. This is precisely where the mandate from Congress for the Commission to use its administrative judgment for satellite systems matters so much. The Commission has an opportunity to make it much more likely that satellite systems offer effective supply alternatives by expanding the spectrum available for TMI/TerreStar and ICO. (The total spectrum assigned to each 2 GHz MSS licensee will still be smaller than the amount of spectrum that Inmarsat holds.) New satellite service systems are commercial ventures with significant risks. But, without attempting to forecast the success of particular technologies, the Commission can clearly make an informed judgment about the general technology path for wireless mobile systems as a whole. This is no different than the Commission's prior recognition that fundamental influences, like Moore's law, had profound implications for the future of telecommunications (e.g., the viability of Internet architecture) without attempting to predict the merits of individual technologies. Today, systems are becoming more demanding with increased computer processing power and more flexible and innovative uses of spectrum. The Commission can also make a judgment about whether the benefits

[12] *See* Strategic Plan at 11 ("The Commission must facilitate efficient and effective use of non-federal spectrum domestically and internationally to promote the growth and rapid deployment of innovative and efficient communications technologies and services.").

[13] Nokia, Motorola, and Texas Instruments, for example, are planning on dual-mode handsets with cellular and WiFi interfaces for their GSM/GPRS handsets. *See* Fanny Mlinarsky and Ian Sherlock, "Cellular or WiFi?" Test and Measurement World, pp. 37-42 (April 2005); Eric Auchard and Lucas van Grinsven, "Intel makes mobile phone push with designs, deals," Reuters (Feb. 25, 2004), *available at* http://biz.yahoo.com/rc/040225/telecoms_intel_1.html (last visited July 29, 2005).

[14] Kevin Fitchard, *Sprint Begins EV-DO Launch*, Telephony Online (July 7, 2005), *available at* *http://telephonyonline.com/wireless/marketing/sprint_evdo_3g_070705/* (last visited July 29, 2005). My accompanying declaration discusses the spectrum holdings of major carriers in the United States and Europe.

of success from satellite systems, and particularly those with an ATC, can materially advance its public interest goals.

As described in the FCC's recently-proposed draft strategic plan, the Commission's key goals include broadband, spectrum, competition, and public safety and homeland security.[15] All of these goals would be advanced by a viable next-generation MSS/ATC service. First, owing to the ubiquitous nature of MSS/ATC services, the 2 GHz providers will deliver high-speed data services at affordable prices throughout the U.S. – including underserved rural areas. Second, the spectral efficiency of ATC, as well as the unparalleled efficiency of the TMI satellite, would serve the Commission's goal of spectral efficiency. Third, two viable 2 GHz MSS/ATC providers would provide an important source of competition to MSS providers in other bands as well as to the increasingly-consolidated terrestrial wireless industry. Fourth, and perhaps most importantly, next-generation MSS/ATC networks would provide first responders and other homeland security officials with a uniquely interoperable, redundant, and ubiquitous communications network. Accordingly, the Commission should ensure that TMI/TerreStar and ICO have access to 2x10MHz of spectrum.

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Date: July 29, 2005

[15] *See* Strategic Plan at 1.

Comments of TMI and TerreStar
WT Docket No. 05-221

EXHIBIT D: Letter from Inmarsat re: Withdrawal of 2 GHz MSS Application

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November 21, 2000

Ms. Magalie Roman Salas
Secretary
Federal Communications Commission
445 12th St., SW
Washington, DC 20554

Re: Inmarsat Letter of Intent to Provide Mobile Satellite Service in the 2 GHz Band, File No. 190-SAT-LOI-97

Dear Ms. Salas:

On September 12, 1997, Inmarsat filed the referenced letter of intent to participate in the FCC's 2 GHz mobile satellite service (MSS) processing round. Inmarsat's letter of intent described a proposed broadband MSS system, Project Horizons, that would have provided personal multimedia communications and highspeed services. The Horizons system was designed to provide communications at net transmission rates between 144 kbps and 432 kbps to user terminals with antennas measuring 0.25 meters in diameter.

More recently, however, the Board of Directors of Inmarsat has decided to construct the Inmarsat 4 system to provide broadband services, including Inmarsat's Broadband Global Area Network (B-GAN) in spectrum Inmarsat is already authorized to use in the L Band. This system, which will consist initially of two orbiting geostationary satellites and one on-ground spare satellite, is scheduled for launch in 2004 and will provide the same functionalities as the proposed Horizons system and more. For example, the Inmarsat 4 system is expected to be fully integrated with terrestrial Third Generation wireless networks and will complement L Band services provided over Inmarsat's currently deployed satellites.

Due to the planned launch of the Inmarsat 4 system, Inmarsat no longer believes that it will be in a position to launch and operate a mobile satellite system in the 2 GHz band consistent with the milestones established in the Commission's Report and Order in IB Docket No. 99-81, FCC 00-302 (released Aug. 25, 2000). Therefore, Inmarsat respectfully requests that the Commission dismiss its letter of intent to participate in this processing round without prejudice. Inmarsat reserves the right to seek FCC authorization to provide MSS in the 2 GHz band at a later date if market conditions and regulatory policies should warrant it.

Sincerely,

Kelly Cameron

Kelly Cameron

cc: Don Abelson
Jim Ball
Tom Tycz
Cassandra Thomas
Fern Jarmulnek
Chris Murphy

::ODMA\PCDOCS\WSH\196138\1